the Cornell

engineer

Beauty and Mystery
in the
Aurora Borealis

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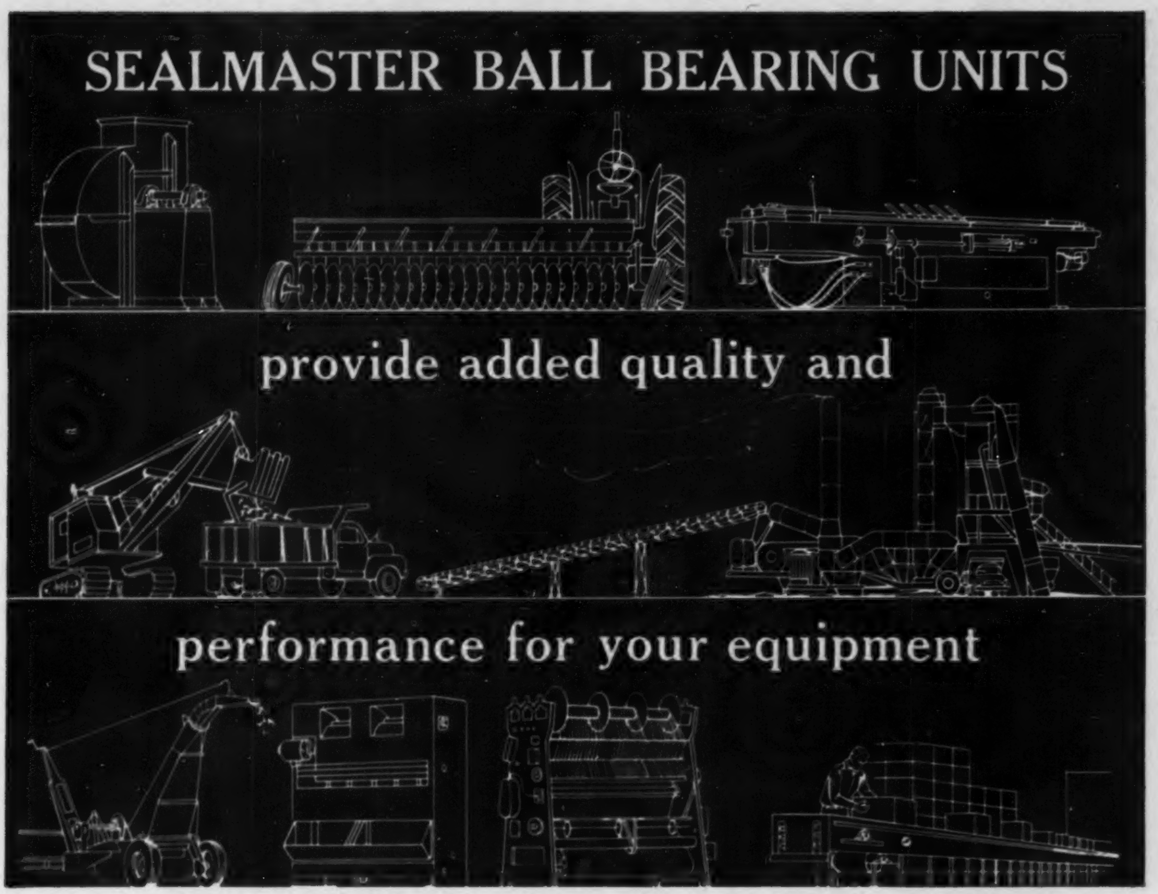

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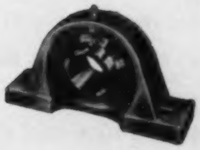

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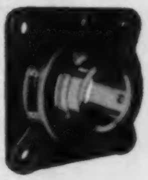

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Editorial . . .

FRESHMAN COUNSELLING PROGRAM ADOPTED

The completion of the fall term found only 75% of the freshmen engineers in good scholastic standing. Alarmed by these figures, the Engineering Council has decided to put into full-scale operation a counselling service which was tried on a pilot-plan basis earlier this year. The Council has recommended that a qualified upperclassman be assigned to assist any freshmen in need of tutoring and guidance. The purpose of the service is two-fold: to provide formal and personal instruction in course material and, perhaps more significantly, to teach the freshmen, by good example, how to study.

The Admissions office accepts a freshmen into the College of Engineering because it feels confident that he is capable of carrying out the work involved. In its decision to establish this service, the Council is implying that a good many of the freshmen in academic straits are in trouble because they have not been able to adjust adequately to the extra load of a college curriculum. The counselling service is intended to direct the freshman, thus making lighter his orientation burdens. This, it is hoped, will in turn raise the academic standards of the college. Upperclassmen have, consciously or unconsciously, developed a set of study habits which cut down the amount of wasted time and effort. They have developed a sense of values pertaining to the apportionment of their work. If they can pass these hints on to the freshmen, hours of wasted energy can be saved.

The counsellors will be presented with a unique opportunity to serve the College. The "cold university" will rapidly be made more livable through increased personal contact with those who have come to know it. Interest on the part of the counsellor would seem to be a prime qualification for the position. Although no financial reward will be involved, none should really be expected. No one would really think of refusing this aid if it were asked of us in a library or student lounge. The fact that this is an organized, efficient means of assistance does not place a dollar value on it.

The Engineering Council is to be congratulated for its efforts in founding and administering this plan. Through this type of project the Council shows its usefulness in a real and meaningful way. The ultimate success of the plan lies, however, with the students' willingness to take part in it.

—Spar

Founded in 1885

THE CORNELL
engineer

APRIL 1961 VOLUME 26 No. 7

COVER design and photographs by Benson J. Simon B&PA '62, show an aurora over Massena, New York, on the night of September 4, 1960. Picture is a monochromatic montage of a 3-second and a 45-second exposure made with an f 2.8 lens on High Speed Ektachrome. Colors on the cover are not meant to be accurate reproductions of colors seen that night, but are merely suggestive of the hues that are sometimes visible in auroral displays. See story about aurora research, beginning on p. 10.

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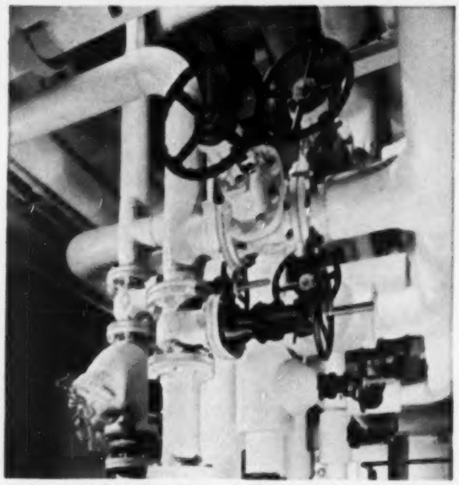

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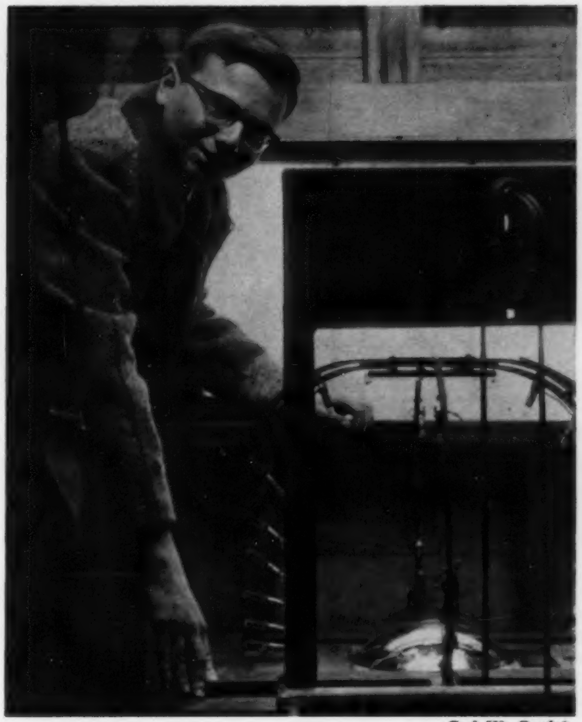
Under the direction of Professor Carl W. Gartlein, Cornell's 23-year-old aurora study program became the nucleus, in the Western Hemisphere, of the great IGY aurora research project. Housed in Hollister Hall, the IGY Auroral Data Center receives and processes vast quantities of information with which . . .



Carl W. Gartlein

Author-photographer Simon and the "all-sky camera." Pictures are taken by a camera aimed up through hole in top of spherical mirror. Flat mirror at top of arch of light bulbs reflects spherical mirror's sky image back down into camera lens. The lights appear in the photographs as white dots which indicate angles of elevation. **See photographs, p. 16.**

SCIENCE PROBES THE MYSTERIES OF THE AURORA

by Benson J. Simon, B&PA '62

Beautiful and terrifying, slowly shimmering or silently exploding against the starry night sky, auroras are among the most spectacular of all natural phenomena – and one of the least understood. Under the direction of Prof. Carl W. Gartlein, the IGY Auroral Data Center at Cornell is intensively working to solve the riddles of these neons of nature.

Benson J. Simon

Professor Gartlein, director of the IGY Auroral Data Center, explains some electronic measuring equipment near his home. Meter at right records aurora brightness.

Auroras have been under study at the University for more than twenty years, but the inception of the International Geophysical Year program in 1957 greatly increased the scale of the research effort. Hundreds of observers across the United States and Canada have been drawn into the work. Technological advances in rocketry, satellites and telemetry have added new dimensions to the research, and the latest techniques in electronic data processing have been called upon to handle the vast quantity of information that has poured into the Data Center.

Auroras Center on Geomagnetic Poles

Auroral displays occur most frequently in the polar regions along two narrow bands that center respectively on the north and south

About The Author

Benson J. Simon majored in economics as an undergraduate in the College of Arts and Sciences, and is currently working for his MBA in the Graduate School of Business and Public Administration. He retired from the Feature Editorship of the *Engineer* last spring and is now Assistant Editor of B&PA's *Balance Sheet.*

IGY Auroral Data Center

Dewey Bergquist, "weather man" of television station WDAY, Fargo, North Dakota, took these two photographs. Both show rayed arc forms. Apparent convergence of rays in photo at right is the effect of perspective. "Coronas" like these are seen whenever the ray forms approach the magnetic zenith, (i.e., the direction in which the upper end of the magnetic dip needle points). Bergquist's photographs are among the most beautiful that the Data Center has been presented with.

Satellite yields exciting information — correlation between

geomagnetic poles. Aurora frequency decreases as one moves toward the center of these bands or out away from them toward the equator. Displays in the north are often referred to as the "aurora borealis" or "northern lights"; southern displays are called the "aurora australis."

Location of the auroral zones about the geomagentic poles immediately suggests that the phenomenon is caused by moving particles originating outside the earth's atmosphere. Widespread auroral activity is most common at the peak of the sun spot cycle and usually occurs about one day after disturbances on the sun. If the particles originated outside the solar system, they would probably show some sort of dependence upon sidereal time. If they originated in the sun, movement induced by the earth's magnetic field would account for their presence during night as well as daytime hours. Hence, it has long been assumed that the sun is the source of the display-causing particles.

Lack of specific correlation between solar events and auroral displays, however, suggests that the particles do not travel directly from the sun to the earth. One of the greatest achievements of IGY was the discovery of the Van Allen radiation belts, and it is now assumed that these belts form a temporary storage chamber for the aurora-causing emissions.

Satellite researchers watched for and finally found a disturbance in the radiation belts that coincided with auroral activity. Dr. James A. Van Allen, who is credited with the discovery of the belts, sponsored the radiation measurement experiment aboard Explorer VII. This satellite was placed in orbit on October 13, 1959, and on November 28 of that year, it picked up "intense spikes" of radiation in the Van Allen belts while passing directly above the top of an auroral arc over Montana. This proved to be the most spectacular finding of the experiment. Radiation was of the lowest energy and highest intensity ever encountered.

Van Allen belts contain trapped solar particles and cosmic rays. Radiation in the belt was high the day before the aurora, but the belt was markedly depleted the day after. Apparently, solar activity somehow triggers periodic "dumping" of the trapped particles. Gartlein, Sprague, Van Allen, Roach and Obrien have written a paper describing the phenomenon.

Unfortunately, few measurements have yet been made in the center of the Van Allen belts. The ends or "horns" of the belts, which come in closer to the earth, have been better investigated, but these relatively close horns do not fall within the auroral zone latitudes. Only the "deep space probes" ("Pioneer" series solar satellites) have penetrated far into the radiation belts.

Spectrographs are Major Research Tool

Spectrometers have long been used in aurora research to help determine the nature of the particles involved in the displays. In the 1940s, Lars Vegard in Norway detected the presence of hydrogen

Benson J. Simon

At the left, Professor Gartlein and Miss Marcia Van Dusen of the Data Center staff make calculations from an aurora chart. Picture on the right shows Mrs. Lorena Jump checking one of the hundreds of aurora maps produced at the Center. In front of the map drawers stands a machine used for viewing all-sky camera film records. A print of two typical all-sky pictures is shown on p. 16. The viewing device is itself an ingenious piece of motorized equipment that permits rapid scanning of the films.

auroral display and disturbance in Van Allen radiation belts.

in the aurora. Dr. Gartlein and Aden B. Meinel, working independently, measured the velocity of the incoming hydrogen ions. The critical experiment was performed about 10 years ago by Prof. Gartlein. He had spectrographs, near Ottawa and Ithaca, simultaneously record the Doppler shift broadening of the hydrogen lines in an aurora. From these records, it was determined that the particles had downward velocities of 2000–3000 km/sec.

It is not yet known what the relative importance of electrons and protons is in causing auroras. Every big aurora is accompanied by bursts of protons, but electrons come in also; and the auroras are often still active when protons are no longer detectable. Aurora spectrographs show the presence of nitrogen and oxygen in molecular, atomic and ionized forms. Studies of the excitation processes for these gases show that the spectra are not greatly different when protons are involved instead of electrons. Some results occur only with electrons, but apparently the col-

Why Not Try For Some Aurora Photos of Your Own?

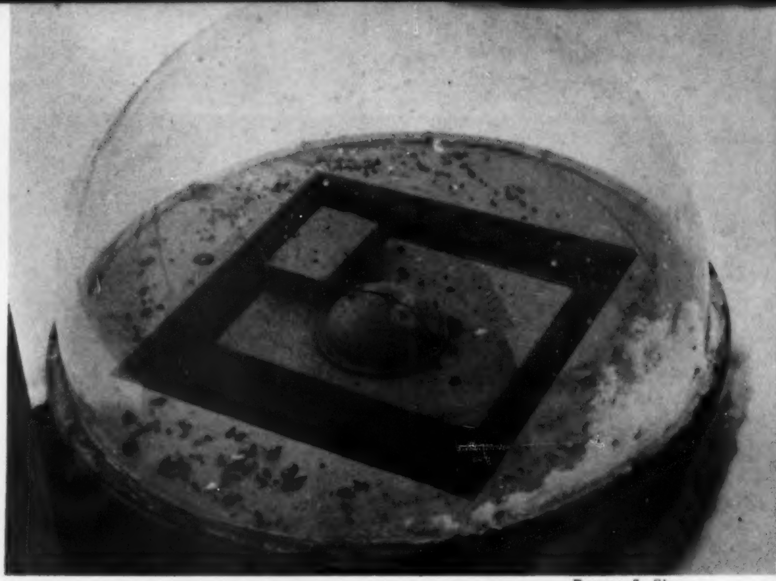
We don't guarantee results like Dewey Bergquist's on the first try (see photographs on opposite page), but creditable pictures can be obtained on today's high speed films after a little practice.

First thing to remember is that auroras do occur several times a year in most northern areas of the United States. All you have to do is keep your eyes open for them.

A camera with at least a 2.8 lens seems to be necessary for really good results. Besides that, you'll need a tripod, a cable release, possibly an ultraviolet filter, a sunshade to keep stray light from streetlamps and automobile headlights out of the lens, and high speed black-and-white or color film. We have taken some very successful shots with High Speed Ektachrome (ASA 160) in a Contaflex with a 2.8 lens. Exposures ranging from 3 to 45 sec all produced good pictures of a particularly brilliant aurora over Massena, N.Y., last September 4. The cover picture is a montage of two photographs taken within seconds of each other that night. (See p. 5 for data.) Exposures of 30 sec to 2 min gave best results for a dimmer but more colorful aurora over Ithaca, June 4. One unfortunate quality about the Ektachrome is its extreme graininess.

Kodak Tri-X seems to give satisfactory results in one-second exposures with forced development. Ansco Super Hypan or Kodak Royal-X Pan (available only in 120 roll size and in sheets) are still faster and should perform well.

Remember that auroras are always shifting, even though they may sometimes look nearly motionless to the eye. Therefore, try and keep exposures as short as possible to get maximum definition in the forms. Get some foreground silhouetted in some of the shots for really dramatic pictures. A wide angle lens helps here if the formations are well above the horizon. And if you're really lucky, you may even capture satellite tracks in some of your pictures.



Benson J. Simon

Professor Gartlein checks adjustments on patrol spectrograph housed in a small building adjacent to his home. The spectrograph photographs the sky at regular intervals all night long. Plastic dome, shown in picture on the right, shields the top of the device from the elements. Bodies of insects that could not find their way out of the chamber are scattered beneath the dome. A light coat of late winter snow surrounds it. Additional spectrographic equipment is housed nearby. Professor Gartlein is an expert spectroscopist. This field was his major interest before he undertook aurora research.

Diverse technologies — from spectroscopy to electronic

lision itself rather than the specific particle involved determines the character of the energy emitted.

Source of the Colors

Variations in atmospheric density are the primary determinants of aurora color. Red, which results from collisions of electrons with atomic oxygen, can only occur in very rare atmosphere. Low-velocity, low-energy electrons excite the oxygen which gives off a deep, vivid red glow. The phenomenon has not been reproduced in the laboratory because "forbidden" metastable energy levels are involved. The atoms would rather give up the energy as heat than as light.

As the accompanying chart shows, it takes a relatively long time before oxygen releases the light energy. Therefore, extremely thin atmosphere is required to provide sufficiently long, collision-free travel times during which the reaction can occur. Red auroras are relatively rare, but a very beautiful one was visible over Ithaca on the night of November 12/13, 1960.

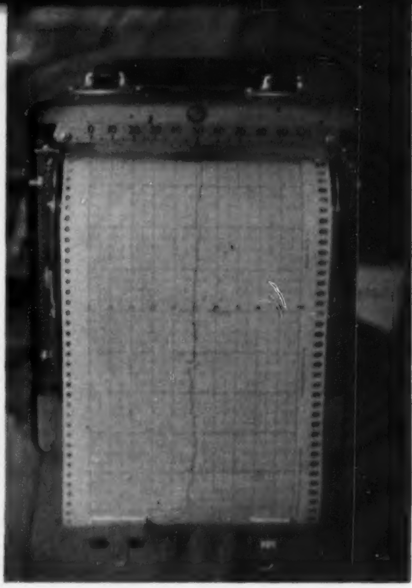
Conditions necessary for a green aurora are similar to those necessary for red, but the mean free paths need not be as long. Therefore, green can occur at lower altitudes. Ions of molecular nitrogen produce blue displays. Combinations of the three primary light colors, red, blue and green, in various proportions produce all the other hues that are sometimes seen in auroras. Red and green together produced brilliant yellow for a brief period during the November 12/13 display.

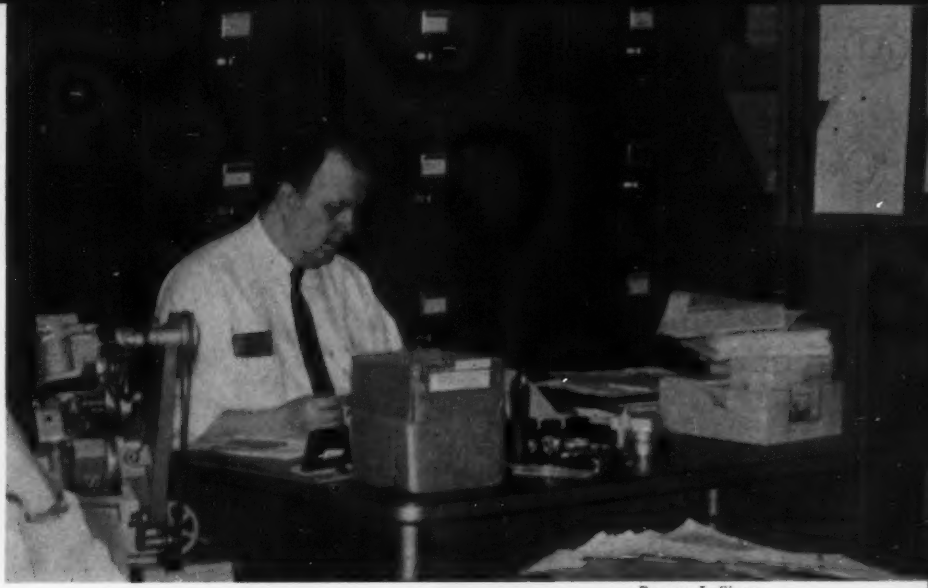
Researchers as yet still have very little data on atmosphere densities during auroras. Normal atmosphere varies three to five orders of magnitude in density over the height of the aurora, but the brightness of the displays only varies by about one order of magnitude over their heights. It cannot be concluded that velocity variations cancel the effects of density changes. There is also no explanation of why green does not appear at higher altitudes. Much is yet to be learned about the relatively low-velocity particles that cause the auroras, but there are many problems involved in building suitable radiation counters for use in the studies. Rockets launched by Carl E. McIlwain of the State University of Iowa have made the only measurements in this area so far.

Role of the Data Center

Fundamental information source for the researchers is still the visual observation reports sent in to

Aurora Color	*Origin*	*Height*	*Average Lifetime Before Giving Off Light Spontaneously*
Red	Usually oxygen atoms	Above 200 mi.	100 sec
Green	Oxygen atoms	60–200 mi.	½ sec
Blue	Nitrogen molecular ions	Anywhere	Instantaneous





Benson J. Simon

Magnetometer shown above is located in the Data Center's Hollister Hall office. Its record of magnetic disturbances alerts the researchers to probable auroral activity. Bulletins on magnetic storms are sent by telegram to the Data Center by the National Bureau of Standards in Washington. Dr. Gale C. Sprague, Research Associate at the Data Center, is shown studying recent reports. Equipment at his right is for film editing. Professor Gartlein and Dr. Sprague both did their graduate work at Cornell. Like Gartlein, Sprague was a spectroscopist before he became interested in auroras.

data processing — are called upon in the program.

the Data Center. Primary object of the extensive observing program is to determine where there is an aurora overhead at any moment. Reports contain information on position, form, motion, color and brightness of the displays.

Problem of organizing the data from the tens of thousands of reports that come in annually is one of the most challenging jobs that the Center faces. Dr. Gartlein has done much of the pioneering work in developing methods of recording, assembling and processing the observation reports. He and his research associate, Dr. Gale Sprague, have become experts in the use of punch cards and electronic data processing techniques. Designing efficient card report forms was, in itself, a monumental task, but one that was an essential adjunct to the basic research effort. Much energy was also expended in arranging for use of similar reporting techniques in the United States and Canada, since the information from the Canadian observers is eventually combined with the United States data. Decisions had to be made on such things as exactly what information was to be recorded and what measuring equipment was to be given the observers. Test runs had to be made with small groups to determine whether the observers could obtain and record the desired data without difficulty. Dozens of problems had to be ironed out before a workable reporting system was put together. In addition, hundreds of volunteer observers had to be recruited and trained.

Dual Data Collection Program Used

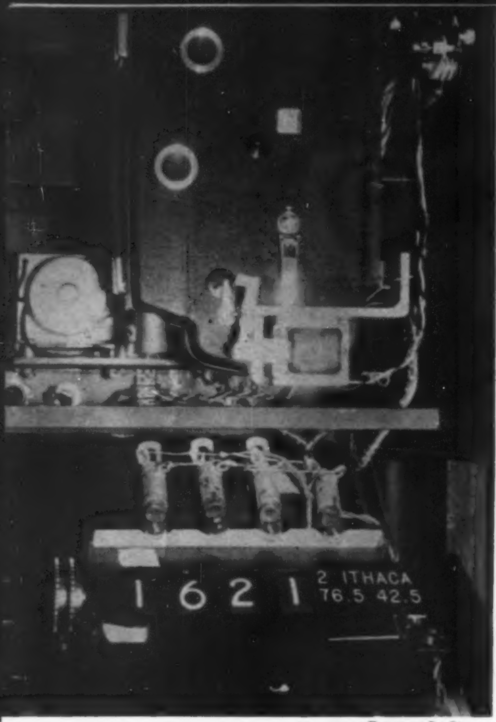
First formal IGY observation program utilized United States Weather Bureau observers. They began sending aurora reports to the University in February 1957. Weather Bureau personnel record their observations simply by blackening appropriate spaces on IBM "mark sense" cards. Machines later "read" these cards electronically and convert the pencil marks into appropriately placed punch holes. Each side of the mark sense cards is divided into three sections, with each section accommodating one hour of observations. The cards, which were designed by Prof. Gartlein, also contain a blank space in which notes on unusual occurrences may be written. (See photographs, p. 17.) "Aerologists" (Air Force meteorologists) in the Antarctic were the first to send reports in on these forms. They began recording aurora observations while the Antarctic bases for the IGY scientists were still under construction.

A small group of volunteers sent in reports on mark sense card forms for two years starting in 1955. It was decided, however, that these forms were too complicated for use in the large-scale volunteer program that was planned for IGY.

Form finally agreed upon permits graphic representation of the aurora on a schematic drawing of the sky. Protractor printed on back of the report form is used with a light-weight, hand-held inclinometer to measure the elevation angle of the bottom of the aurora.

The sky is represented by four separate quadrants outlined on the other side of the card. The forms of the aurora are sketched in these quadrants in the proper positions. Data on time, date, location, weather conditions, motion, color and brightness are written in.

Measurements of elevation angles made from different locations permit calculation of the actual altitude of the display. Observations are supposed to be made



Benson J. Simon

IGY Auroral Data Center

Shown at left is the inside of the all-sky camera. Rectangular device in the top center of the picture is a 16 mm movie camera whose lens aims up through hole in center of convex mirror. Numbers on panel tell the time, and are included in the pictures. Camera sees reversed image of numbers and convex sky mirror reflected in flat mirror as shown in picture on p. 11.

Data pours in from all over Western Hemisphere.

every 15 minutes on the quarter hour, but the extent to which the observer sticks to schedule, and the frequency with which he makes reports, varies with the individual.

A third card report form is sent in by observers in the Antarctic. It carries essentially the same information, but is used with an alidade instead of an inclinometer to measure elevation angles.

Treatment of the Reports

All three report forms are shown in the photographs at the top of p. 17. The pictures show what is done with the data after it reaches the University. Close-up on the left shows the three forms on which data are sent in. They appear in a row across the top of the picture. On the left are shown both sides of a Weather Bureau mark sense card. The three one-hour divisions on each side are visible. In the center is shown a volunteer report form. Protractor on the back of the card is at top; sky quadrants on the front are beneath it. On the right is an Antarctic alidade card. The one shown in the picture was received from the South Pole.

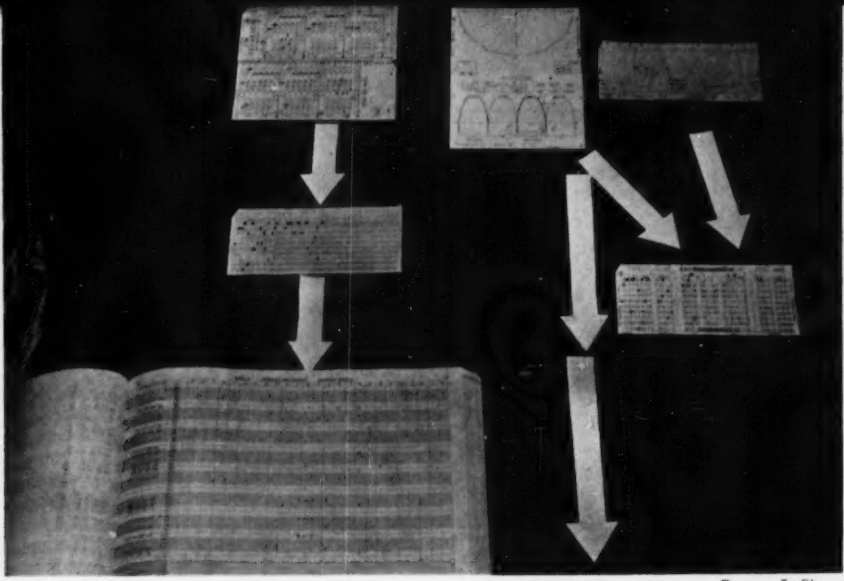
First step in processing the report data from the volunteer and the Antarctic observers is to enter the information on a specially designed punch card form. This is done on a key punch machine in the Data Center. Resulting card is the one on the right of the picture toward which the two slanting arrows from the observer cards point. Once on these cards, the data can be stored for future publication. The information is occasionally printed out and sent to the observers to show them how their reports are being handled. Card sorting machines can be used to assemble all the reports of one observer or all the observations at a given hour or given latitude.

Treatment of the mark sense cards from the 50 Weather Bureau report stations is somewhat different. These go to the Machine Records Division office in Day Hall where the pencil marks are translated into punch holes. The information is then read off the cards and automatically repunched into "15-Hour Universal Time Cards." One of these punch cards is shown at the left of the photograph, just below the mark sense observation card. By ingenious use of another electronic data processing machine, the aurora data from these cards are translated into XY map coordinates and printed out on the "green sheets" shown bound together in the book that is below the U.T. punch card. Plastic overlays allow the sheets to be read in terms of geomagnetic coordinates. The Center pays $1000–$1500 per month for the services of the Machine Records office.

Maps Produced

At this point, the data from the Weather Bureau and the volunteers is brought together. The continuation of the process can be followed in the other photograph. Data from the "green sheets" is entered on map forms designed by Dr. Gartlein and Dr. Peter M. Millman of Ottawa. Then the information from the volunteer cards, arranged by date and hour, is added to the maps. There may be as many as 2000 cards for one night. Finally, Canadian data and photographic information recorded by "all-sky cameras" are added. Mrs. Gartlein does the mapping.

Next form in the process is the "Visoplot" which charts time v. latitude. Two of these forms are shown lying on the lower left portion of the map. They are made for international use and contain in less detailed symbolic form most



Benson J. Simon

Above is a close-up of the incoming data report forms. At top left of the picture are both sides of a Weather Bureau mark sense card. In the center is a volunteer card with protractor and sky quadrants. Antarctic card is at upper right. "Green sheet" is at lower left. Whole sequence of data processing described in the text is shown in the photograph at the right.

Benson J. Simon

IGY aim: Make information available to all.

of the aurora data on the maps. Each Visoplot covers 45° of geomagnetic longitude. Eight such charts are thus required to represent the whole circumference of the earth. Four of the eight sectors are covered by the Ithaca Data Center. The Visoplots are a good index of what detailed data are available, and they will eventually be published.

As shown in the picture, another set of punch cards, one for each hour, is derived from the Visoplots and is used to produce the statistical chart shown at the bottom. From these charts, various curves are constructed. The "green sheets" and microfilms of the maps are sent to the two other World Data Centers.

The IGY Program

A primary object of the IGY Program was to insure that collected data would be published in accessible places. International agreements simply stated what data were to be exchanged; establishment of an exchange system was left to the people involved but no satisfactory plan has developed. World Data Center A, which is housed in Hollister Hall, processes all aurora reports from the Western Hemisphere, and Australia, New Zealand and the United States Antarctic bases. Center B, located in Moscow, receives information from the USSR and "related peoples." The work of Center C is divided among several European universities, and covers primarily Western Europe.

Officially, the International Geophysical Year began on July 1, 1957, and ended on December 31, 1958. Some of the research programs were terminated at the end of IGY, others were continued at a reduced pace, while some, like the aurora research program, were maintained at almost the same pace. More than a quarter of a million dollars has been allocated to the Ithaca Data Center by the National Science Foundation and IGY. Current budget is $40,000 per year.

Prior to IGY, support came mainly from the National Geographic Society. The University and the United States Information Agency also contributed. USIA, which still lends some support to the research, is interested in finding a method of predicting auroras so that their effects on the Voice of America radio transmissions can be anticipated.

Just what other materially valuable results the aurora research program may yield is anybody's guess. Evidently, there is some tie-in between auroral displays, solar activity, cosmic radiation, disturbances in the earth's magnetic field and changes in the deadly Van Allen radiation belts. The Van Allen belts were undreamed of before IGY research led to their discovery. Ability to predict changes in radiation intensity within them may determine whether or not men will be able to travel through them into space. Perhaps an unexpected finding in the satellite program will again coincide with an unusual aurora and provide the key to more new knowledge about the space around us.

Scientists will be aiming spectrographs, cameras, radars and rockets at auroral displays for years to come before all the riddles about them are solved. But the beauty of the aurora will always be with us. Take a quick glance at the sky once or twice on clear, dark nights. If you are in the northern half of the United States, away from the bright lights and smog of the metropolitan areas, chances are that you will see several brilliant displays each year. They are thrilling sights that you will never forget.

ATOMS AND THE UNIVERSE

by Lloyd Goldman, EP '64

The idea of a minute particle of matter as an indivisible "building block" for all things is not a recent concept. About twenty-three hundred years ago, a Greek philosopher, Democritus, formulated this idea. He could not believe that matter, no matter how homogeneous it appeared to be, could be composed of identical fragments that would look the same, no matter at what degree of magnification an object was observed. On the contrary, he believed that all substances were composed of a large number of very small particles which he called "atoms" or "indivisibles." According to Democritus, the atoms "differed in quantity in various substances, but their differences in quality were only apparent and not real. Fire atoms and water atoms were the same in fact, differing only in appearance. Indeed, all materials were composed of the same eternal atoms."[1]

A contemporary of Democritus had a somewhat different view. This man, Empedocles, "believed that there were several different kinds of atoms, which mixed in different proportions, formed all the multitude of different known substances."[2]

Empedocles, basing his reasoning on the facts available to him, recognized four different types of atoms corresponding to the then popular conception of four elementary substances: stone-stuff, water-stuff, air-stuff and fire-stuff. The combinations of these various elementary substances were shown by the ancients to be a truly logical explanation for their observations of certain phenomena. For example, the simple reaction of the rusting of iron, shown today by the formula $4Fe + 3O_2 \rightarrow 2Fe_2O_3$ would have been indicated by the ancient alchemist as (iron molecule) $\rightarrow$ (stone atoms [rust]) + (Fire atoms).[3] This concept persisted until 1803 when the modern atomic theory was proposed.

The modern concept of the structure of the atom has been evolved through experimentation in the last century and a half. In the nineteenth century, when, upon the basis of empirical evidence, the existence of such an elementary particle as had been advanced by Democritus was shown to be true, the theory of "indivisibility" was incorporated into the concept. To account for the combination of the various atoms, certain geometrical shapes were assigned to the elements which hypothetically accounted for their properties. For example, the atoms of hydrogen were considered as being nearly spherical, whereas the atoms of sodium and potassium were believed to have the shapes of elongated ellipsoids.[4] An example of the application of this theory is shown in figure 1. These crude attempts to explain the properties of the atoms made very little progress.

The first constructive attempt to "dissect" the atom was made by the British physicist Joseph J. Thomson (1856-1940). Thomson believed, and was able to show, that the atoms of various elements consist of electrically bound positively and negatively charged parts. Thomson's conception of the atom was a more or less uniformly distributed positive charge containing a large number of negatively charged particles, "floating" so to speak, in its interior. The combined positive and negative charges caused the atom to be electrically neutral. Since the negatively charged particles, or electrons as he called them, were assumed to be bound fairly loosely to the whole, it was possible to remove or to gain several electrons creating, respectively, a "positive ion" or "negative ion." This process of loss or gain of electrons is known as "ionization."

Thomson based his concepts on the work of Michael Faraday. Faraday had proved that "whenever the atom carries an electrical charge it is always a multiple of a certain elementary amount of

electricity numerically equal to 5.77 x 10^{-10} electrostatic unit."[5] Thomson proceeded further with this knowledge by attributing these charges to individual particles, by developing methods to remove these particles from the body of the atom, and by studying the beams of high-speed electrons. By such experimentation, Thomson estimated the mass of the electron to be approximately 1840 times smaller than the mass of a hydrogen atom. Logically, this indicated that the greatest part of the atomic mass was to be found in the positively charged part of the atom.

In 1911, Ernest Rutherford (1871–1937), through his study of "alpha particles," determined that, contrary to Thomson's opinion, the positively charged parts of the atom occupied only a small part of the size of the atom. He discovered through his experimentation that these positive charges, as well as the greatest part of the mass of the atom, were located in a very small "nucleus" at the center of the atom. The electrons, then, rotated about the nucleus in a situation analogous to that of our solar system and were bound to the nucleus by the attraction of their electrical charges which, incidentally, obeyed the same laws as did the gravity forces acting between the sun and its planets.

As a result of the foregoing discoveries, scientists were able to attribute the properties of the elements to the number of electrons rotating about the nucleus of the atom. Through the development of the periodic laws, the chemist was able to predict the results of his reactions and the reason behind such reactions.

Modern experimental evidence indicates that matter is made up of the following units:

A. THE PROTON. The proton is the unit of positive electricity. Its mass is approximately one on the atomic weight scale. It may be a neutron combined with a positron. A hydrogen ion (H^+) is a proton.

B. THE ELECTRON. The electron is the unit of negative electricity. One electron weighs $\frac{1}{1845}$ part of a hydogen atom.

C. THE NEUTRON. The neutron is a particle of unit mass (approximately the same as the proton) but with no electric charge. It may be made up of one electron closely bound to a proton.

D. THE ALPHA PARTICLE. This particle, of mass 4 and positive charge 2, is shot out, at high velocity, from the nuclei of radioactive atoms. A helium ion is an alpha particle.

E. THE POSITRON (positive electron). The positron is a unit of positive electricity of approximately the same mass as the electron. It is obtained by the action of cosmic rays on matter. However, positrons are more readily produced by bombarding sheets of aluminum, beryllium or magnesium with alpha particles.[6]

In addition, another sub-atomic particle discovered is the "meson." The broad definition of a meson is "a name given to several types of particles intermediate in mass between electrons and protons. Mesons may have positive or negative charges, or may be neutral. Some of them appear to be of importance as the agents that bind together the various particles in an atomic nucleus.[7] A few examples

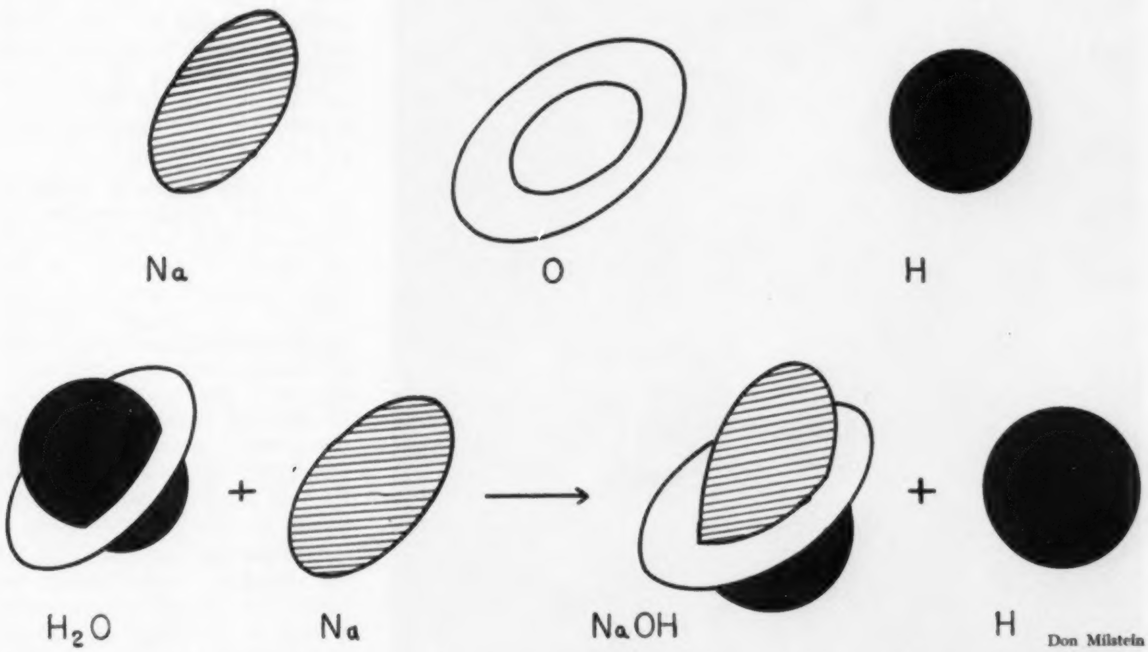


Fig. 1. The reaction of sodium and water to form sodium hydroxide and hydrogen gas by means of geometrical matching as proposed by Rydberg in 1885. Those reactions that could not take place were assumed to fail because of their different shapes, i.e., one just cannot put a square peg firmly into a round hole.

are the pi (π) meson, the mu (μ) meson, the sigma (σ) meson, the rho (ρ) meson, and the lambda (λ) meson, all of which fit the general definition, but have different properties.

Also there is evidence of the existence of a miniature neutron called a neutrino.

A structural drawing of the atom (according to modern concepts) is shown in Figure 2.

Creation of the Universe

Having discovered these experimental facts concerning the structure of the atom, science has attempted to reconstruct the creation of matter in the universe by working with the information at hand. Cosmogonists (scientists who ponder the origin of the world) have advanced many theories concerning the creation of matter. According to modern theory, the entire universe was at one time compressed into a highly dense mass at extremely high temperatures. These conditions were extremely favorable for all kinds of nuclear transformations. Since the relative amounts of the different atomic species produced during this "universal cooking era" must have been determined by the prevalent physical conditions of that time, a knowledge of the relative abundances of the chemical elements in nature should allow us to "recreate the creation" of matter.[6]

We have a large amount of material on the subject of relative abundances of elements due to the exhaustive studies of a great many geophysicists and astrophysicists. The data comes from chemical analysis of the earth's crust and of the meteorites that have survived entrance into our atmosphere, supplemented by spectral analysis of interstellar space and the various bodies contained in the universe. The unusual result of these studies has been that the chemical constitution of the universe is surprisingly uniform. It has been found that about 55 per cent of cosmic matter is hydrogen, about 44 per cent is helium, and the remaining 1 per cent accounts for all heavier elements.

Scientists have not yet reached agreement on the origin of the universe. This "island universe" is a collection of stars, similar to our own Milky Way.

Our own earth is a remarkable exception to this distribution as it is almost lacking in hydrogen and helium. This, however, is a purely local effect. It results from the fact that our planet (also Mars, Venus, and other minor planets) was formed by the aggregation of interplanetary d u s t, producing what may be called a "planetary core." Gaseous matter did not participate in this process until the planetary core had become large enough to capture the gases by gravitational forces. Our planet and other minor planets did not attain the necessary size for this process. The major planets, however, (Jupiter and Saturn, for example) exceeded this critical size and surrounded themselves with heavy atmospheres of hydrogen and helium. Thus, the 55:44:1 ratio is preserved in all except the small planets and satellites.

Upon observation of charts of the relative abundance of the elements, we notice a rapidly descending curve corresponding to the rapid drop of the abundance of the elements. However, after reaching the elements with an atomic weight of 100, the curve levels out, showing nearly equal abundances for all elements in the upper half of the periodic system. Any theory concerning the production of matter must, therefore, satisfy the conditions of the abundance curve.

The earliest interpretations of the abundance curve logically assumed that the curve represented a kind of alchemical equilibrium of the various atomic species. They concluded that this equilibrium must have existed when the temperature of matter was sufficiently

high to cause all kinds of nuclear reactions and then must have been "frozen" when the temperature dropped due to the expansion of the primeval mass. This, then, is the "hypothesis of frozen equilibrium."

A situation similar to this may be produced in the laboratory by raising a liquid, such as water, to a high temperature and then cooling it quickly. The resulting mixture is in a state of "metastable equilibrium" and is highly explosive. This analogy could be used to explain the fact that certain atomic species can react with one another, releasing tremendous amounts of nuclear energy. Upon expansion of this theory, however, the hypothetical abundance curve that resulted varied considerably with respect to the actual determined curve. This tended to refute this theory. Attempts to "patch up" the theory were not successful and it is extremely unlikely that it is correct.

Therefore, about twenty years ago, a Belgian scientist, Georges Lemaitre, formulated the "hypothesis of the primeval atom." According to Lemaitre, before universal expansion began, all the matter of the universe was in the state of dense nuclear fluid. This formed a giant nucleus similar to ordinary atomic nuclei, but on a much larger scale. Thus, the scientist implied that at the beginning of expansion the temperature of matter was below the "critical temperature" of nuclear fluid, so that the thermal motion of nucleons could not break the cohesive bonds binding them together into one continuous fluid. This fluid, upon expansion, became mechanically unstable and broke up into fragments of all sizes. As Lemaitre said in the *Revue des Questions Scientifiques* in 1931:

> The atom world broke up into fragments, each fragment into still smaller pieces. Assuming, for the sake of simplicity, that this fragmentation occured in equal pieces, we find that two hundred and sixty successive fragmentations were needed in order to reach the present pulverization of matter into poor atoms which are almost too small to be broken farther. The evolution of the world can be compared to a display of fireworks that has just ended: Some few red wisps, ashes, and smoke. Standing on a cooled cinder we see the slow fading of the suns, and we try to recall the vanished brilliance of the origin of the worlds.[9]

Lemaitre did not follow up his hypothesis with a mathematical analysis of this fragmentation process. Independently, however, Maria Meyer and Edward Teller of Chicago arrived at similar conclusions about the origin of atomic species.

Beginning with the stage where the individual fragments were reduced to a size of several miles in diameter and to a mass comparable to an average star, they proceeded with their hypothesis.

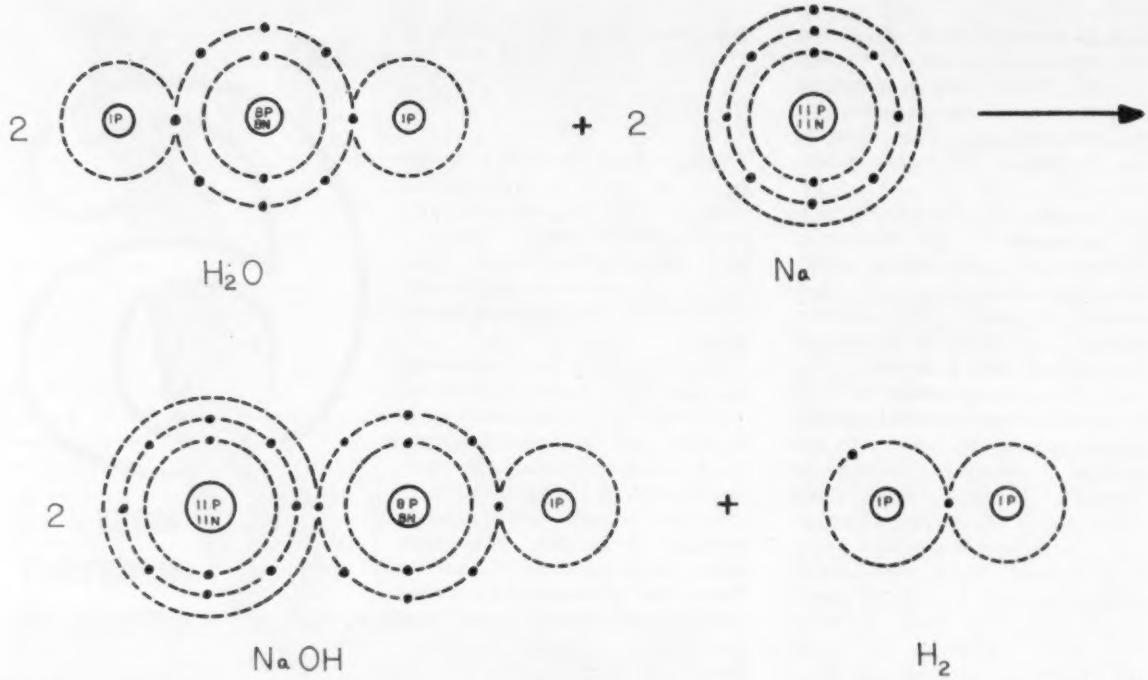
At the moment of the creation of these "atom stars," they must have consisted entirely of neutrons. Due to the neutron$\rightarrow$proton + electron transformations these large "polyneutrons" must have become positively charged with a thin electronic atmosphere.

Meyer and Teller, by studying the mechanical stability of these large atoms, showed that "the giant nucleus would be quickly covered by a multitude of miniature pimples or buds about 10^{-12} centimeters in diameter. These buds would separate from the mother's body and fly away in the form of a fine spray carrying the nuclei of different heavy elements."[10] This theory does not account for the abundance of lighter elements, however, and any attempts to patch up this hypothesis have not proved successful.

Hypothesis of Ylem

Finally, we come to a third possibility, "the hypothesis of the 'Ylem.'" This theory assumes the original state of matter is a "hot nuclear gas" (not a fluid). It also assumes that no real equilibrium was ever established and, instead, treats the situation as a fast dynamic process.

Then, according to the theory, we find ourselves in a situation where the temperature of the universe was many billions of degrees high. At these temperatures we measure the kinetic energy of thermal motion in millions of electron volts, a situation similar to the conditions in a modern atom-smashing machine. Since no nuclei, as such, could have existed in such



Don Milstein

Fig. 2. Diagram represents the reaction 2 H_2O + 2 Na → 2 NaOH + H_2, according to modern-day concepts of atomic structure. Atomic nuclei are surrounded by electrons, and bonding is shown to be a result of a sharing of electrons between atoms.

a medium, the nuclear gas must have consisted entirely of free protons, neutrons, and electrons. It is known that free neutrons are intrinsically unstable and break up into protons and electrons within 13 minutes after being kicked out of the nucleus. At very high temperatures, neutrons can exist with protons and electrons in considerable numbers. Under such extreme conditions a type of dynamic balance will be established. The decay of neutrons ($n \rightarrow p + \bar{e}$) is compensated for by the building of neutrons by the reverse process ($p + \bar{e} \rightarrow n$). The term used for this mixture of nuclear particles is "Ylem", reviving an obsolete noun that means "The first substance from which the elements were supposed to be formed."

When the Ylem began to cool, the $p + \bar{e} \rightarrow n$ reaction must have slowed down, then stopped, due to the lack of fast thermal electrons. The decay of neutrons must have then proceeded without compensation so that at the end of an hour there could not have been many free neutrons. On the other hand, the lowered temperature made conditions favorable for an aggregation process in which neutrons joined with protons causing aggregates of particles to form with varied degrees of complexity. These aggregates were the prototypes of today's atomic nuclei.

The number and type of the nuclei created were directly affected by the temperature and density. The situation needed to cause an abundance curve as is observed in nature is a low density at a temperature just below 10^9 degrees centigrade.

Today, cosmogonists generally believe in two theories of the creation of the universe, the "steady-state" theory and the "big bang" theory. The former states that matter is being created continuously in the form of aggregating hydrogen atoms that form galaxies and move apart. The latter states that, at one time, the matter in the universe was all concentrated in a small volume of space, and then a vast explosion scattered the matter, which formed into galaxies and fled into space.

Very recently, an English astronomer by means of a radio telescope brought to light evidence in support of the "big-bang" theory. He discovered that colliding galaxies get more crowded in space as they get farther away. According to this Astronomer, Martin Ryle, it is natural that they seem more closely packed. Those that are 8 billion light years away occur eleven times as thickly as those near to the Earth. Since he is actually viewing these galaxies as they were 8 billion years ago (since radio waves travel at the speed of light, that is, they cover one light year of distance in one year of time), they were closer to the original bang at that time and had not had time to spread out as thinly as at present.[11]

Thus, it appears that we are coming closer to discovering the origin of matter as well as its structure. But, of course, the future still holds many mysteries that remain to be solved by the inquisitive mind of science.

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AUTOMATION

ITS EFFECT ON THE WORKER AND HIS JOB

Part II of 2 Parts

by Reginald F. Woods III, ME '62, BPA '63

Automation vs Job Security

Contrary to much popular opinion, the coming of automation to a plant can bring a previously unheard-of measure of security for the worker and his job. In the new highly automated facility, direct labor has been reduced to a minimum. The plant cannot operate at all unless a certain minimum base work force is in attendance, and this force may actually be considerably larger than the minimum for the same plant in conventional configuration. At any production rate short of complete shutdown, this work force has a guarantee of continuity of activity which was completely absent in the conventional situation. This occurs because the smallest increment of labor is now a "group" of employees required to keep the automated line functioning, rather than a single individual (one of several) who performs, say, one machining operation. In other words, if the plant is to produce anything at all, the workers of this "group" *must* be on hand. Thus, we now find a lower limit on the employment level that is considerably higher than in the conventional plant.

The magnitude of investment demanded by the automated production facility is usually much greater, and its operating characteristics are such that the fixed costs almost always run higher than in a conventional plant of similar capacity. For these reasons, company management has a much stronger incentive to keep the plant operating at a fairly high production level to meet or exceed the new and higher break-even point. Also there is economic pressure to run steadily for quickest investment recovery.

Automation vs Wage Policy

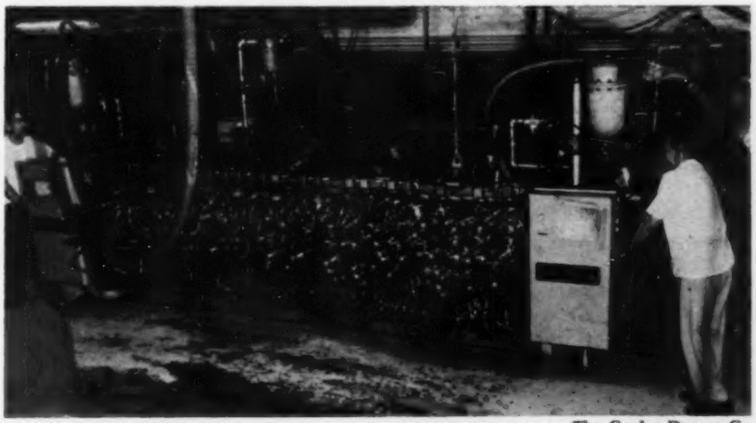
The introduction of automation tends to stimulate wage demands because it increases productivity and also brings greater profit margins to the participating company. Compounding these problems in the area of general wage level are new complications resulting from wage differentials. In general, such wage differentials arise between: (1) skilled and unskilled labor, (2) labor in automated sectors of the plant and labor in non-automated sectors, (3) automated and non-automated firms within the same industry, and (4) automated and non-automated industries.

As pointed out earlier, when a plant or industry becomes automated, the need for skilled labor rises and the need for unskilled labor falls. Automation also implies a strong increase in the demand for engineering and scientific workers. It would therefore seem desirable for a wage policy to tolerate sufficiently wide differentials to stimulate an adequate number of individuals to acquire the necessary training which is very often both costly and lengthy.

Recent industrial surveys indicate the noteworthy fact that the most common justification for wage increases due to the introduction of automation is the gain in productivity. A vice-president of manufacturing is quoted by Bright[1]:

> "You just have to give the worker more money. He sees more work going through his work station and so he figures he deserves more. Sure, the job is easier and he doesn't contribute more effort or brains. But you can't sell that . . . You might as well make up your mind to giving him part of the gain."

A substantial number of executives concur with the above — with reservation — and employ it in practical operating practice. Other administrators apparently feel an ethical obligation to share the benefits of increased productivity with the labor force. Still others show no intention of increasing wages merely because the company has a more productive facility which at the same time makes the worker's job easier. They believe that productivity gains and increased profit margins should be laid aside as a reserve against the next and succeeding wage demands which labor will inevitably make.



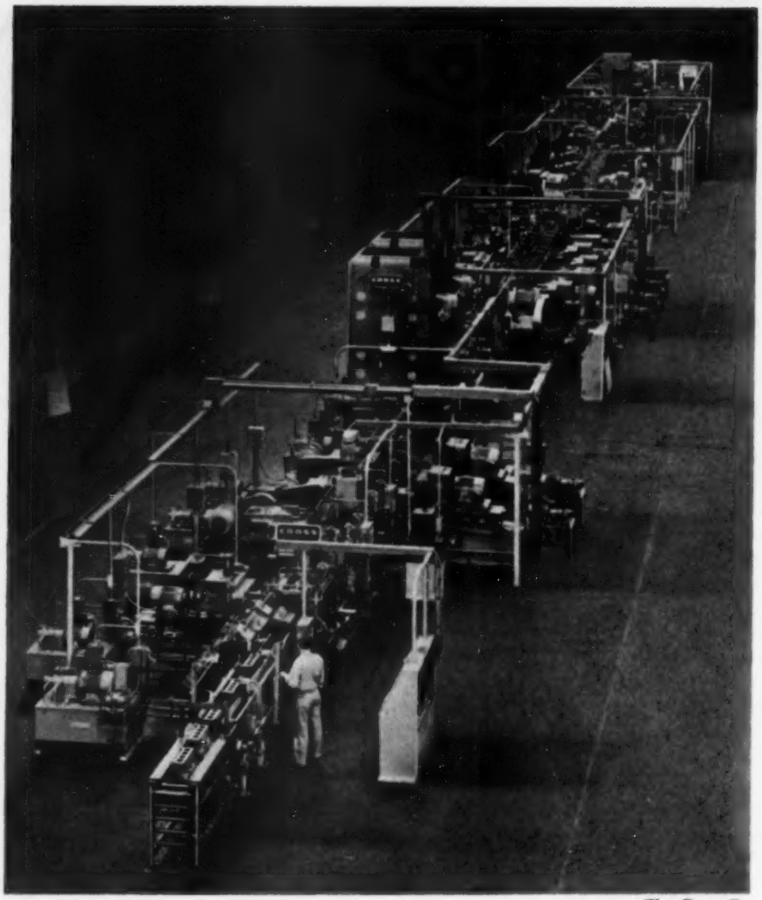
The Garden-Denver Co.

Banks of automatic air drills used on an automobile production line. The unit contains an indexing system so as to drill according to style and model without changing drills.

In its attempt to relate wage increases to automation, management often makes the disastrous error of overestimating the skill requirements of certain jobs. This leads to the establishment of wage rates that may be unequitable to the company and far out of keeping with the contributions of the individual worker. Payment by piece-work, based on the output of the individual worker, is evidently not very well suited to automatic production. The production rate is predetermined by the plant management and is controlled by technicians rather than by the workers. Moreover, the contribution of one worker can rarely be isolated from the contributions of others, so that payment will very likely tend to reflect the performance of the work "group", or the whole factory in extreme cases, rather than that of the individual. Although evidence is far from conclusive, the technique of job evaluation is likely to find wider and wider acceptance throughout industry as a means of establishing a "fair" wage.

Unfortunately, however, the straightforward application of job evaluation techniques does not solve the problem quickly and easily. When management applies its traditional job evaluation program to the automated wage-job question, the indicated result is nearly always the same. The automated job is worth less than the former conventional job. The decision must then be made whether or not to accept or reject the job evaluation analysis. Since the purpose of job evaluation is considered to be the rating of jobs relative to each other and not against some absolute standard, it appears that job evaluation can be made practical and effective by the introduction of new factors and change in weighting of certain of the traditional ones.

The reorganization of job evaluation techniques and policies which seems to be indispensible will be painful, complex and time consuming, particularly in a plant where both automated jobs and conventional ones exist under the same roof. Here the traditional job evaluation system will indicate a downgrading of jobs which appear to the worker to be far more important and complex. The old weighting of factors will result in obvious inequities. The greatest difficulty may arise when a rating scale is applied to highly automated jobs when former workers are utilized. The wage administrator will be forced into creating more and more inequities. His job evaluation system will indicate lower wages but he will be forced to at least maintain the present ones regardless of job content. Gradually, this may almost completely destroy any validity in the comparative ratings. Even more seriously (and, I think, unfortunately) the range between the upper and lower wage levels will less fairly represent the differential in contribution by the more skilled, experienced, and capable worker.



The Cross Co.

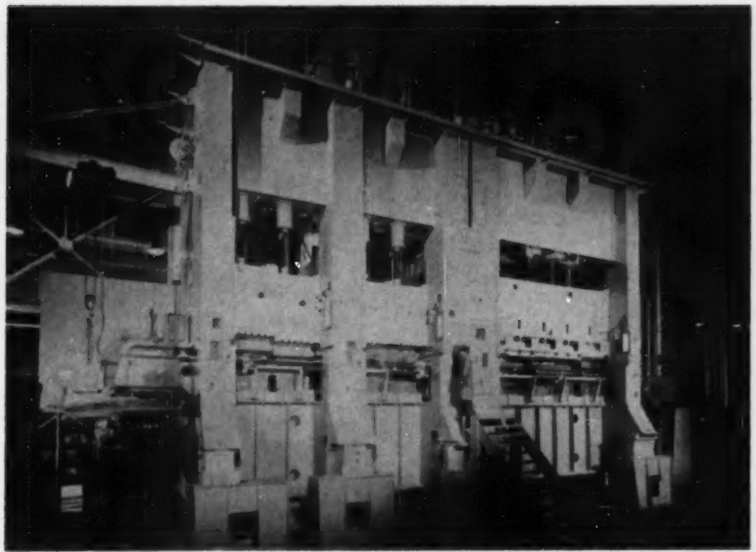
This automatic system is used in the production of small-car engine blocks. It consists of four separate units whose functions include milling of the block ends, and boring of the cylinders.

The Labor Viewpoint

Leaders of organized labor are quick to answer charges that they are opposed to automation. At the National Conference on Automation, Walter P. Reuther of the UAW said:

"We have said many times that we welcome automation and that we are going to encourage the expeditious development of this new technology, just as we encouraged the development of other phases of our technical development. But we are going to insist, as free citizens in our great and wonderful democracy that responsible national policies be devised to insure that this new-found power will be used with a sense of moral and social responsibility in terms of the needs of the whole community."[5]

In the later Congressional Report on Automation and Technological Change, eight union leaders, including Walter Reuther, Joseph Beirne, and James Carey, outlined in more specific detail



Cleaving Division of U.S. Industries, Inc.
This huge piece of equipment is an automatic transfer press used in the manufacture of tops for washing machines. The complete unit is operated by only one man.

what they mean by "responsible national policies". These leaders presumably represented unionism as a whole when they proposed a basic five-point program made necessary by the reality of automation on the American labor scene:

1. A substantial general wage increase to stimulate the consumption of increased production capacity.
2. A shorter work week to spread the remaining jobs among the present work force.
3. An increase in unemployment insurance, a guaranteed annual wage, some sort of technological displacement benefit to provide protection for the individual displaced worker.
4. Training programs to enable these displaced workers to develop the skills necessary to obtain other jobs either in other industries or to secure one of the new class of jobs in the automated plant.
5. New specialized taxes designed to impede the rate of factory automation, or strong collective bargaining tactics which will force management to introduce automation only after sufficient guarantee of job protection for the present work force.

Summary

It should be apparent, even now, that the impact of automation in the next ten years will be strong and extensive, though many industries may remain relatively unaffected, at least directly. Although the larger companies are evidently in a better position to realize the potential gains of automation, the benefits will by no means be denied to small industry. Many smaller firms are finding that their factories and products are ideally suited to automation both technically and economically.

As automation becomes more widespread, its importance will become increasingly apparent to the social and economic atmosphere of the whole country. Just as other technological advances increase efficiency and reduce cost, automation will increase production and at the same time enable the products to compete favorably in both foreign and domestic markets. It seems likely that automation will also raise our living standard, create a nationwide requirement for skilled and educated personnel, abolish most of the heavy and monotonous jobs, and revise the nature of skills and emphasis on teamwork in such a way as to improve the industrial atmosphere with a new sense of job satisfaction.

However, the coming of automation will not be without serious difficulty and readjustment. Labor and management must solve the inevitable problems in a mature atmosphere of cooperation and mutual understanding if automation is to spread widely without causing the social and economic strife that marred the formative years of the Industrial Revolution.

The transition to automation will be relatively painless if fair consideration is given to the feelings, needs, and problems of the workers concerned, and if organized labor can be consulted and "educated" before steps are taken. At the present time there is much union concern over the possibility of automation causing unemployment, but this effect is unlikely as a direct result of automation alone, provided that its introduction is

The Rapids-Standard Company
Part of a system of conveyors in the Naval Supply Center in Bayonne, N.J., providing rapid handling of materials with a limited amount of manpower.

not too rapid and uncontrolled. The spread of automation will probably be controlled most effectively by the shortage of technical and scientific manpower and by the need for large capital investment in new equipment, rather than by public policy or collective bargaining. These possibilities, however, do not minimize the fact that management must plan its manpower requirements well in advance in terms of numbers, skills needed, and formal qualifications desired, to avoid the dangerous risk of having too little or too much labor.

The inevitable changes in skill will also be made more smoothly if they are carefully planned, if adequate provision for on-the-job training is made, and if the workers are consulted and kept well informed of future developments. Of course, there will be difficulties in acquiring skills, particularly among the older workers; in persuading workers to accept the shift work necessary to a continuous production schedule; and maintaining the worker's interest in his job.

The field of automation is in its infancy and its students have much to learn. Present knowledge of the economic and social implications of automation is sadly inadequate when compared to the knowledge of technical possibilities. In the coming years much time and money must be spent on research in these areas. Thus it has become imperative to extend knowledge in the industry through cooperative research and exchange of experience, especially through the medium of actual case-histories of firms which have introduced and are using automatic production. There is much to be done.

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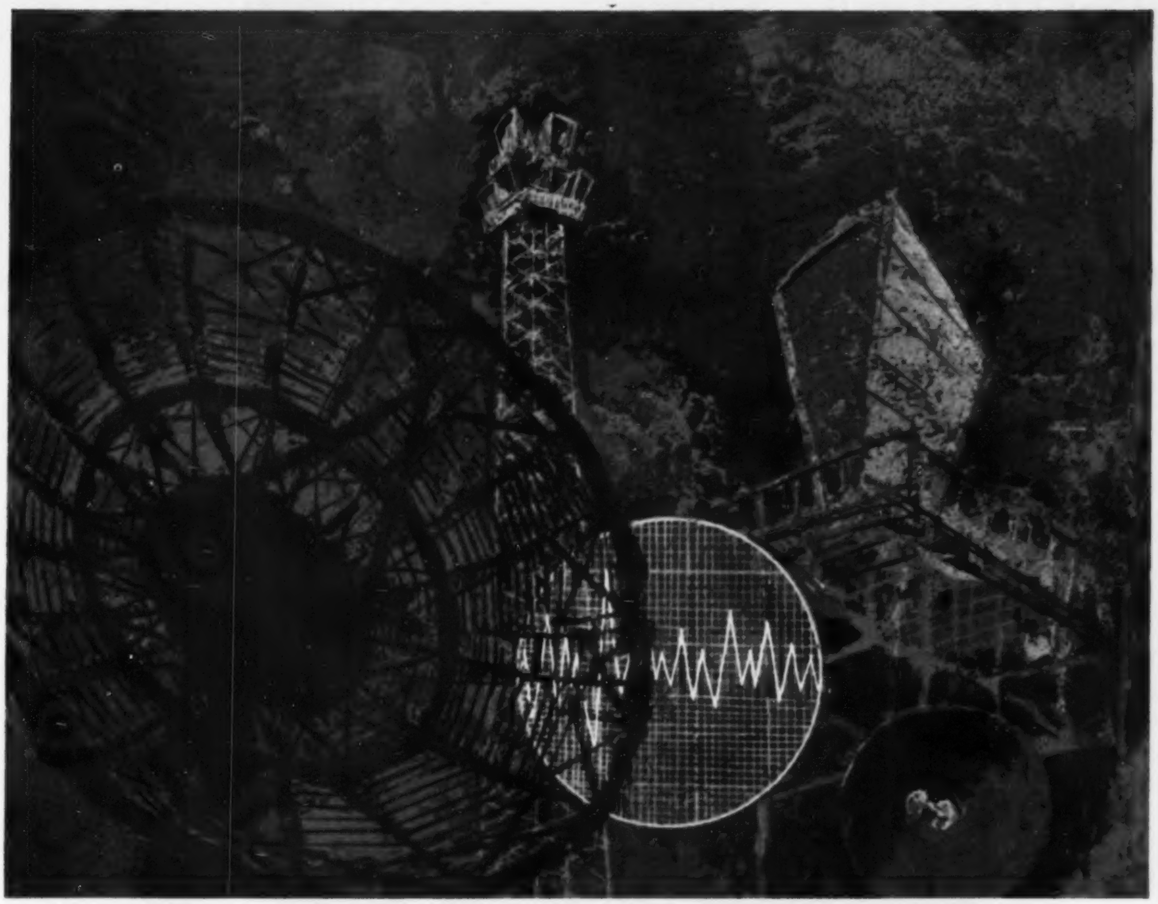

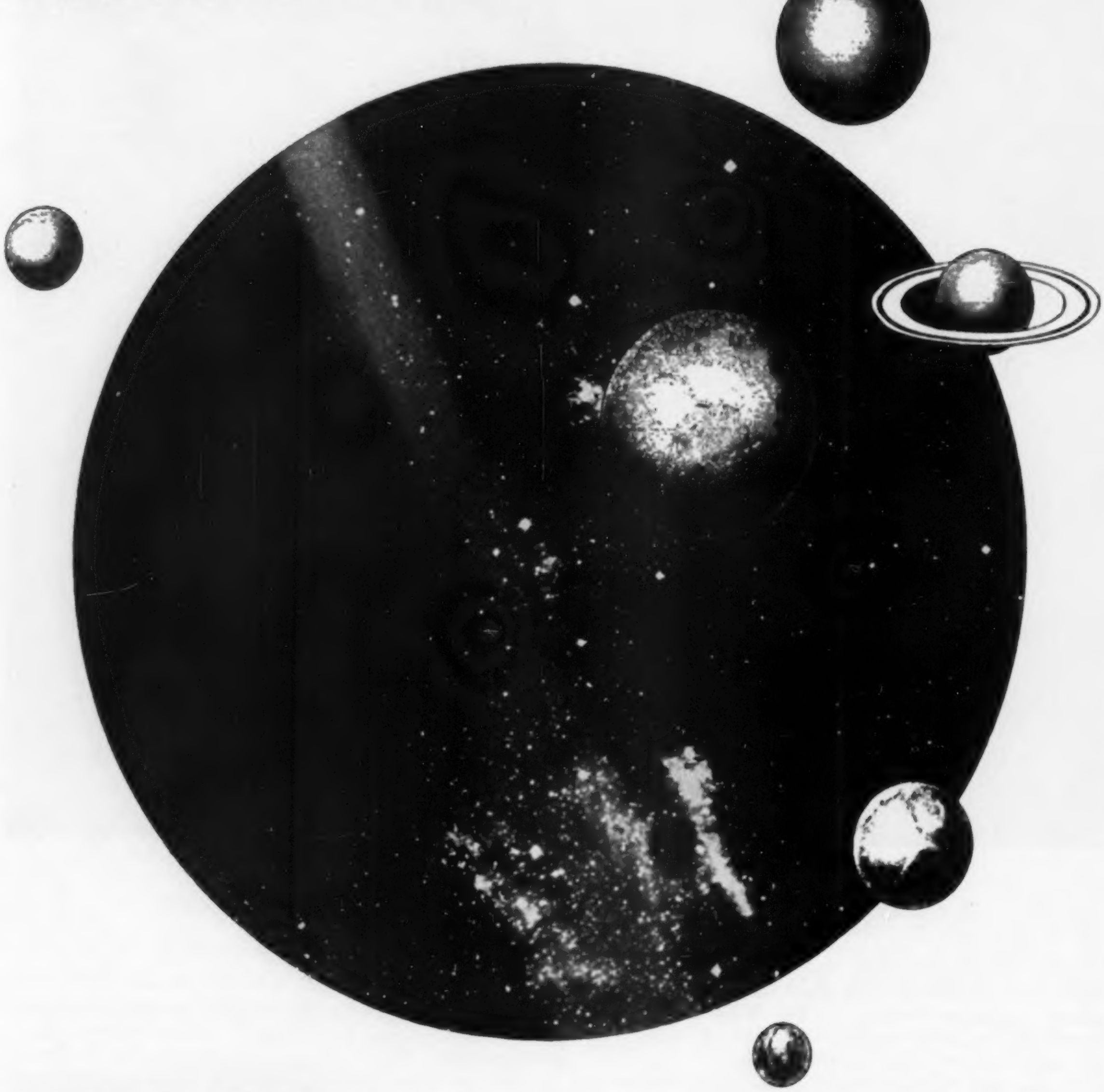

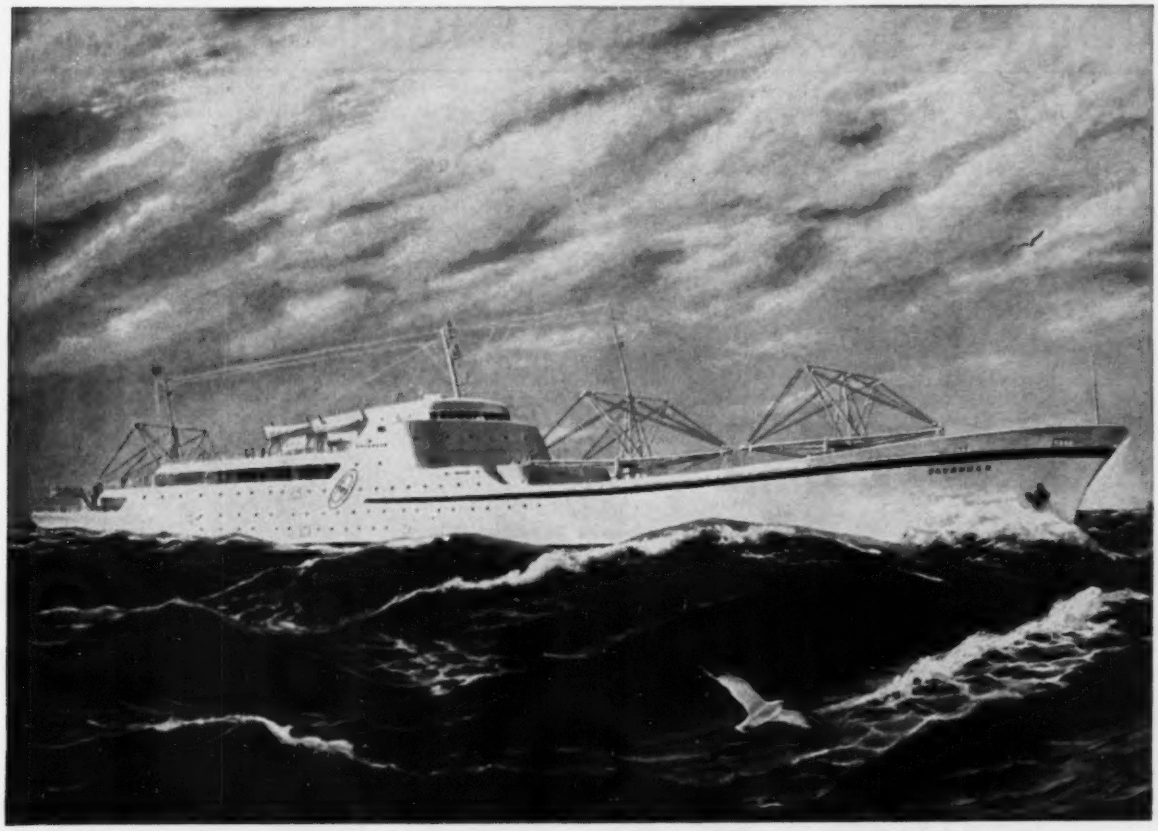

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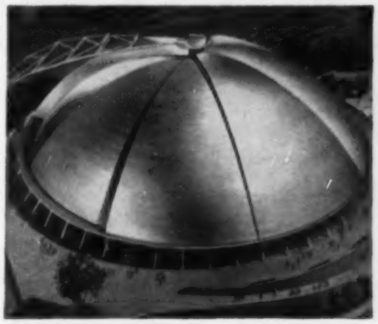

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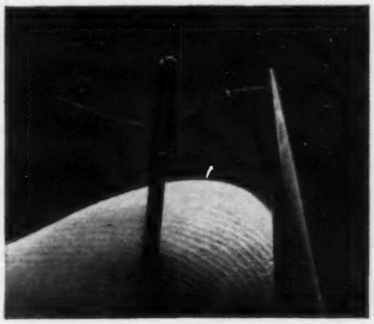

Needle's eye reveals relative size of a Thermistor, a tiny bead made with Nickel oxide—used to measure temperatures in and beyond the earth's atmosphere. The Nickel oxide helps develop electrical properties for the accurate recording of temperature changes as small as 1/50th of a degree!

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"The objects of this Society are to promote the welfare of the College of Engineering at Cornell University, its graduates and former students, and to establish closer relationships between the College and its alumni."

THE PRESIDENT'S LETTER—

One of the pleasant experiences of the last month was the Annual Banquet of the Cornell Engineer held in Ithaca on March 17, at which time the new Publications Board took over. I think we can all be proud of the magazine which these undergraduates put together. I would like to extend my congratulations to the outgoing Board for the fine work that they did and the close cooperation we had with them. I would also like to extend best wishes to the incoming Board who are facing a real challenge in maintaining the standards of the Cornell Engineer.

I am sure all of you read the article of Professor Malti in the January issue of the Cornell Engineer regarding Technical Education and Research in India. In this article Professor Malti mentioned the need of textbooks and other technical publications in the libraries of the Engineering Schools in India. I have heard from a number of you asking what arrangements might be made for contributing books for this purpose. I have discussed this briefly with Professor Malti and we believe that it will be possible to work out a suitable means for doing this through the joint efforts of Professor Malti and the Cornell Society of Engineers. I expect to see Professor Malti later this month and hope to develop a workable plan. Will keep you informed as to our progress.

As to Society meetings – the Chicago Chapter is having a joint dinner with the Cornell Club of Chicago on April 20 at the Lake Shore Club. The Boston section is planning a joint meeting with the Cornell Club of New England during the first week of May, the details of which are not yet firm. The Annual Meeting of the Society will be held May 4 at the Engineers' Club, 32 West 40 Street, New York City.

—Paul O. Gunsalus

ALUMNI ENGINEERS

Edited by William D. Nickles Jr, EE '65

Harold R. Williams, C.E. '26, president and founder of Fusion Engineering Company in Cleveland, has recently developed a completely automated system for large scale soldering or silver blazing. What makes his newly developed equipment intriguing to prospective users are the promises that it will reduce soldering costs as much as 90% compared with current mass production methods and will reduce rejects to less than 1%.

The machine operator merely places the two pieces of metal to be joined in a special holder on a conveyor belt. As the belt moves, an electronic eye actuates a solder-paste alloy dispenser which measures a preset amount of the material on an exact spot. The assembly continues through a gas flame which melts the solder and completes the joint. The finished piece then drops off into a bin – one every three seconds.

Samuel B. Nelson, C.E. '26, has been appointed general manager of the Los Angeles Department of Water and Power, in charge of more than 11,000 employees. Mr. Nelson has been an engineer and executive with the department for thirty-four years. For five years he has been chief engineer. In addition to his duties with the department, he is state-wide water operating engineer for the California civil defense. He is president-elect of the Los Angeles section of the American Society of Civil Engineers and a member of the executive board of the California section of the American Water Works Asociation.

Frederick H. Guterman, M.E. '42, has been named president of the industrial products division of the International Telephone and Telegraph Corporation in Los Angeles. Prior to this, he was general manager of the San Fernando Valley division of IT&T. He is a member of the Intitute of Aeronautical Sciences, Institute of Radio Engineers, Institute of Navigation, Air Force Association, and American Ordnance Association. At 39, he is the youngest IT&T president.

Photoscience

Frederic H. Guterman

Richard B. Steinmetz, E.E. '22, has been elected to the boards of directors of Anaconda Company's two wholly-owned fabricating subsidiaries, the American Brass Company and Anaconda Aluminum Company. Mr. Steinmetz has been associated with the Anaconda organization since 1929. He was elected president of Anaconda Wire and Cable Company, a 70%-owned subsidiary of the Anaconda Company on October 21, 1959.

Anaconda

Richard B. Steinmetz

Thomas Duncan, E.E. '27, is chief electrical engineer for Consolidated Edison Co., New York City. Mr. Duncan has been identified with the design and development of overhead and underground electric distribution systems. Under his direction Consolidated Edison has made significant contributions in the introduction and advancement of high voltage network distribution.

Joseph S. Ward and Associates Inc., Consulting Soils and Foundation Engineers of Philadelphia, announced the formation of a new office and laboratory for soil testing.

The laboratory will be under the direction of Vice-President **Alan Cohen, C.E. 1955,** and will undertake engineering, supervision, analysis, and consultation.

Mr. Cohen is also the holder of an M.C.E. degree, a registered Professional engineer, and a member of the Cornell Society of Engineers.

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Our hundreds and hundreds of highly specialized engineers and technicians are an all-important part of it, and so are our master lens grinders who can hand-polish a lens to tolerances of a few millionths of an inch.
Some of these men can trace their career back to the days when Kollsman became a household word among fliers as **the** flight instrument company. We still are. But ever since the boundary between air and space disappeared, we have been finding ourselves more and more in the space part of the aerospace business.
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COLLEGE NEWS

Edited by Dale Henderson, EP '64

NEW PHYSICS COURSE TO BE MODERN IN ALL WAYS

Changes in teaching introductory physics are being made at the University in order to stress atomic and space age innovations, as well as the humanistic aspects and cultural impact of the science.

Lyman G. Parratt, chairman of the Department of Physics, expresses the thinking this way: "Almost everyone is talking these days of the need for more or better science education. At Cornell we are trying to do something about it. Our first effort is the drastic revision of our first-year course – designed especially for students who do not intend to major in science."

The course gives a fresh approach to the principles of all science in their present-day form. Unlike conventional college physics courses, the Cornell course faces up to the fact that enormous progress in our understanding of the physical world and the structure of matter has been made in the last 30 years – that modern description of most physical phenomena requires use of the quantum theory.

Up-to-date topics such as electron clouds, quantum theory of chemical binding, Fermi energy, Einstein's theory of relativity, nuclear structure, cosmology and conservation of parity – conventionally "too advanced" for introductory physics textbooks – are covered.

Although principal emphasis is given physics, some of the humanistic aspects of the science and its impact on our culture – on philosophy, religion, politics, history and even art will be included.

Associate Professor Jay Orear, who is in charge of the course, has written a new text for it; "Fundamental Physics," just published by John Wiley & Sons, Inc.

The book, which emphasizes scientific reasoning instead of memorization, is as modern in layout and design as it is in its approach to the teaching of physics. A novel 8½-inch square format permits open white spaces on its pages for diagrams or notetaking, while the written text is terse and simple. The book follows the Cornell concept that stress must be laid on understanding fundamental principles as opposed to the mastery of a scattered collection of apparently unrelated facts and applications.

CORNELL RESEARCH PROGRAM TO BENEFIT UNDERGRADUATES

Nearly 30 college undergraduates will have a unique opportunity to gain research experience by working directly under scientists of the University faculty this summer in a program sponsored by the National Science Foundation.

The programs, most of them lasting ten weeks beginning in mid-June, will be in chemistry, microbiology, plant pathology and electrical engineering. Outstanding students will be chosen by the departments to participate in the program; students interested in working in microbiology and plant pathology need not be Cornell students.

The Foundation has made available $32,135 in four grants to Cornell through its Undergraduate Research Participation Program, designed to help build the interest of superior students in research, to increase their understanding of scientific methods, and to improve their ability to employ scientific investigative procedures.

Associate Professor Simpson Linke, advisor to the *Engineer*, will direct the program in the School of Electrical Engineering. Six students will be chosen from the top quarter of the present fourth-year class and will work on projects already in progress in such areas as electric arc phenomena, instrumentation of high voltage cable tests, and energy conversion. Some may join in radio astronomy activities and the work of the Cornell Center for Radiophysics and Space Research. The work done by the students during the summer will prepare them for projects to be performed in their fifth year.

Professor Melvin L. Nichols, executive officer of the Department of Chemistry at Cornell, will direct the program in his department. Ten students will work under individual professors on various projects. Cornell student participants will be limited to those selected from the top quarter of the junior group of chemistry majors or the senior group who have already participated in an academic year of Honors research and who have been admitted to a graduate school.

In microbiology, Professor R. F. Holland, head of the Department of Bacteriology and Food Science, will direct the program in which eight students will work under various professors, six during the summer session and two during the 1961–62 academic year. These research participation positions are open to upperclass students in the top quarter of their college classes and need not be Cornell students. Each professor in the department will work with one student.

Professor George C. Kent, head of the Department of Plant Pathology, will direct the research training program in his department. The department will select five students to take part in the 10-week session this summer. They need not be Cornell students nor plant pathology majors but must be outstanding students.

The Cornell professors who will direct the programs also hope that the students may become interested, through the program, in research and graduate study. Few undergraduates have the opportunity to learn research methods, and the Foundation expects the program to provide them with knowledge of what science is and how scientists work in a way that no other experience can provide.

PROFESSOR DAVID CLARK IS NEW DIRECTOR OF NUCLEAR LAB

David D. Clark, Associate Professor of Engineering Physics at the University, has been appointed director of Cornell's new Nuclear Reactor Laboratory scheduled for completion next June.

His duties will involve coordinating the training and research

programs which will utilize the two reactors being built here; one a "zero power" reactor for research, the other a training and research reactor called TRIGA (Training Research Isotope General Atomic). The former was obtained under a grant from the National Science Foundation; construction of TRIGA is supported in part by an Atomic Energy Commission grant. Total cost of the Laboratory will be about $1,660,000.

Professor Clark came to Cornell in 1955 from the Brookhaven National Laboratory, where he had been research associate since 1953. Previously he worked as a physicist with the University of California Radiation Laboratory and as a graduate teaching assistant at the University of California.

A native of Austin, Texas, he received the bachelor of arts and doctor of philosophy degrees from the University of California. He has published several articles in technical journals, and was the recipient of an Atomic Energy Commission fellowship during 1952–53.

At Cornell, he has served on the University Radiation Safety Committee, the Graduate Committee in Engineering, the Committee on Physics for Engineers and the Nuclear Engineering Committee, of which he is chairman. He belongs to the American Physical Society and the American Nuclear Society.

KRUMHANSL NAMED DIRECTOR OF ATOMIC AND SOLID STATE LAB

James A. Krumhansl, professor of physics at the University, has been appointed director of Cornell's Laboratory of Atomic and Solid State Physics, succeeding Prof. Robert L. Sproull, recently appointed director of the Cornell Materials Science Center.

As head of the Laboratory of Atomic and Solid State Physics, one of the first such laboratories to be incorporated in any university, Professor Krumhansl will direct and coordinate solid state research in physics and engineering physics.

Professor Krumhansl has been associated with physics, electrical engineering, and research administration in both industry and higher education. He has been involved in research on pulse communication, microwaves, network theory, analog computers, operations research, applied mathematics, theoretical solid state physics, chemical physics, and industrial research planning.

A native of Cleveland, Professor Krumhansl received the bachelor of science degree from the University of Dayton, the master of science degree from Case Institute of Technology and the doctor of philosophy degree from Cornell. For a year after completing his Ph. D. studies in 1943, he was instructor in physics at Cornell.

From 1944 to 1946 he was a physicist with the Stromberg-Carlson Company, and then went to Brown University as assistant professor, becoming associate professor of applied mathematics and physics. In 1948 he returned to Cornell as assistant professor of physics, becoming associate professor in 1950. In 1955 he joined the National Carbon Division of Union Carbide Corporation and became associate director of research before returning to Cornell in 1959 as professor of physics.

He has been active as consultant, committee chairman and participant in various committees and conferences in many phases of research. He has served as consultant to the Stromberg-Carlson Company, the M. W. Kellog Company, International Business Machines Corporation, General Electric Company, North American Aviation, the Haloid Company, Union Carbide, and General Atomics.

Editor from 1957 until 1960 of the "Journal of Applied Physics," he also serves on the editorial boards of the "Journal of Physics and Chemistry of Solids," the "Journal of Solid State Electronics," "Progress in Ceramic Science," "Non-Crystalline Solids," and the "Journal of Semiconductor Technology."

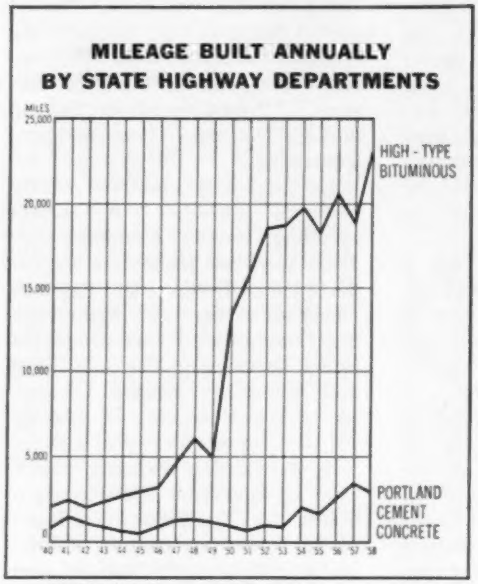
He is deputy chairman of the National Academy of Science Standing Review Committee on Basic Materials Science for the Department of Defense, and has been chairman of the Solid State Visiting Committee of Oak Ridge National Laboratory, the Solid State and Metallurgy Review Committee of the University of Chicago for the Argonne National Laboratory, the Gordon Research Conference on Chemistry and Physics of Solids, and the Publication Board of the American Institute of Physics. He serves on the steering committee of the International Conference on Magnetism and Magnetic Materials.

A recipient of a Guggenheim Fellowship during 1959–60, his organizational affiliations include the American Physical Society, AAAS, Sigma Xi, and Phi Kappa Phi, and the Ithaca Yacht Club.

Mickey Schlick

Prof. James A. Krumhansl, who was recently appointed director of Cornell's Laboratory of Atomic and Solid State Physics, will coordinate research in those fields.

Why America's state highway engineers give first choice to Modern High-Type Asphalt Pavement:



SOURCE: U.S. Bureau of Public Roads

The graph on the left shows you that in 1958 *alone* the use of high-type Asphalt pavement increased *618%* over 1940. This is because advances in engineering know-how, in Asphalt technology and in the development of the mechanical paver have made modern, high-type Asphalt pavement the first choice of highway engineers. Its more economical construction and low maintenance costs have saved many millions of tax dollars and kept America's wheels rolling.

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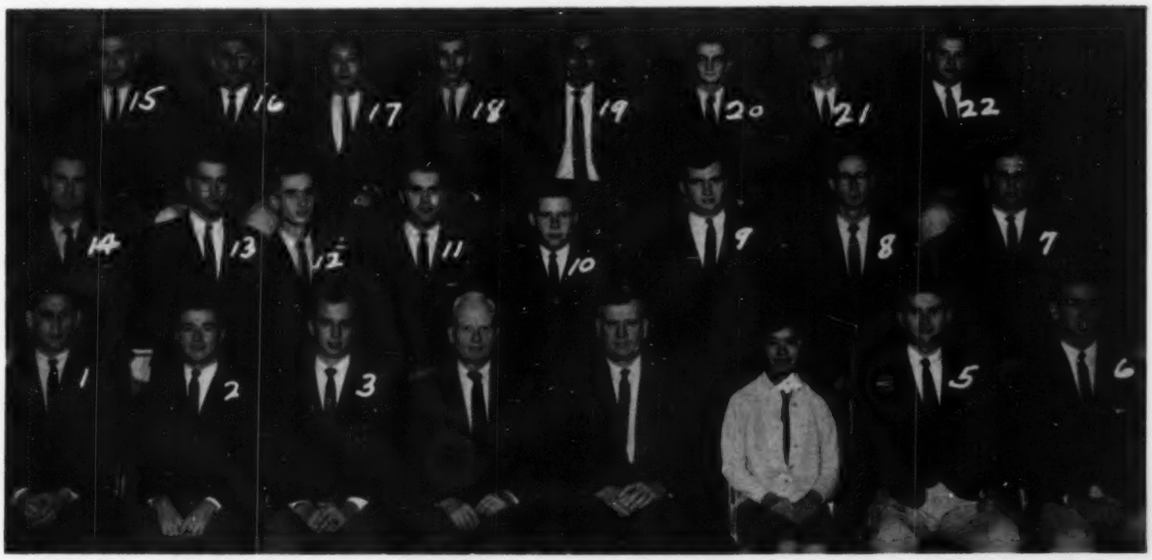
School of Civil Engineering

Class of 1961



1. Garritt, Claude; 2. Herkenhoff, Phillip; 3. Wehran, Fred Jr.; Prof. W. L. Richards; Prof. N. A. Christensen; 4. Hu, Priscilla; 5. Carskaddan, Phillip; 6. Block, Frederic; 7. Sadusky, John; 8. Freeman, Richard Jr.; 9. Butz, Ronald; 10. Metsch, Burton; 11. Catto, William; 12. Kemp, James; 13. Jaschik, Nathan; 14. Kovacs, William; 15. Volckmann, Carl; 16. Pagano, Salvatore; 17. Lee, Frederick; 18. Garfinkel, Alan; 19. Tolani, Chandru; 20. Baldino, Joseph; 21. Camejo, Daniel; 22. Gilvary, Robert.

TECHNIBRIEFS

Edited by Howard Clapsaddle, ChemE '65

SPECIAL GLASSES FOR SPACE FLIGHT

According to Corning Glass Works, two new types of glass they manufacture were used as solar cell covers on several U. S. satellites. The covers, used in many configurations – squares, circles, trapezoids, and rectangles up to nine inches across – protected the solar cells from the extremes encountered in space flight: high temperatures, thermal shock, and micrometeorites.

One of the special glasses, "Code 0211" glass, is an optical grade material sold in very thin sheets. It transmits light well at working temperatures close to 500 C. Code 7940 glass, the other type, is made of fused silica. It is more expensive than Code 0211 glass, but it comes in two grades and its performance justifies the higher price. While Code 0211 glass darkens quickly under radiation, the fused silica becomes only slightly tinted at tremendous exposures of about $1.4 x 10^{10}$ roentgens. Code 7940 fused silica has a normal working temperature of 900°C, with a maximum of 1100°C, about double that for Code 0211 glass.

The glasses are well-suited for many optical purposes for they can be joined to surfaces with cement and can be coated with films which act as filters. The Optical Department at Corning points out that the readily available glasses can be made into many different configurations and sizes.

NEW MATERIALS BETWEEN PAPER AND TEXTILES

The DuPont Corporation has announced the development of a new family of materials, called "textryls," similar to both paper and textiles. Either "Dacron" polyester, "Orlon" acrylic, or nylon fibers, teamed with similar fibers for strength, may be used to make the material.

Papermakers have been searching for a way of making paper from synthetic fibers. But these fibers could not be easily bonded like those of natural woodpulp. Webs of synthetic fibers, poorly bonded, lacked strength and were thus difficult to handle.

Now DuPont has solved these problems, and textryls can be made on regular paper-making machinery. The major difficulty, that of bonding the fibers, was overcome with the discovery of "fibrids." Fibrids are small bunches of fibers thinner than those which form the web of textryl material. Projections of fibers from each fiber serve as hooks to hold the web together so that stronger bonds can be created by heat fusion.

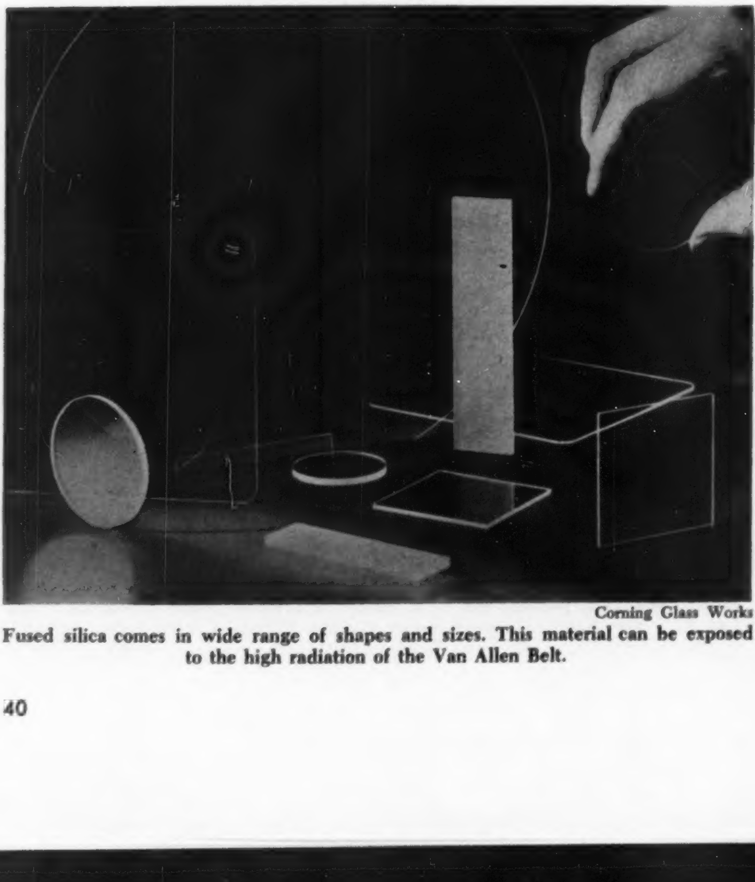
Paper-textured textryls are 50% stronger than ordinary paper, and by a different process, textile-like materials can be made. All textryls are extremely resistant to wear caused by flexing or folding. They are able to withstand attack by chemicals and light, and are insensitive to moisture because of their non-organic composition.

Interlinings of wash-and-wear suits were the first commercial applications of textryl fibers. The resilient qualities of the material tested well, so textryl textiles may soon be more widely used by the garment industry. Other textryls of different weight and thickness have a wide range of possible uses, from automobile upholstery to paper for maps and charts.

COMPUTER AIDS IN DESIGNING OF A NEW COMPUTER

The Burroughs Corporation has announced that their computers have not only designed other computers, but have helped in actually constructing them. Burrough's new computer, the B5000, is the product of the "brainwork" of the Burroughs B220 computer.

The B220 was fed logical equations and mathematical formulas; it digested them and directed it-



Corning Glass Works

Fused silica comes in wide range of shapes and sizes. This material can be exposed to the high radiation of the Van Allen Belt.

Burroughs Corp.

Scale model of the new Burroughs B5000 information processing system. The time required for the development of this computer was cut an estimated year with the use of "designing computers".

self in the basic planning of the B5000. It produced blueprints, and created the electrical design system of the new computer.

The B220 formulated control data for the vital operation of wiring the B5000. It supervised a special machine which did the wire wrapping more accurately and about eight times faster than human workers. Other phases of the construction of the "5000" were controlled and completed automatically.

Burroughs B5000 is, according to the president Ray R. Eppert, "One of the most powerful tools yet devised for the solution of complex business and scientific problems." It is a medium-priced computer; it automatically schedules itself, and carries out its own testing and maintenance program when it runs short of work; it is the first system designed especially for using automatic programming languages. And the "parent" of the amazing B5000 was none other than another computer.

"SQUEEGEE" PUMP ALLOWS UNUSUAL APPLICATIONS

"The pump that never gets wet", the Randolph Pump, operates on a principle designed to eliminate all contact of moving parts with the fluid being pumped. Intake and outlet are one continuous flexible tube which passes through the pump body where it is exposed to the squee-gee action of ball-bearing rollers.

By selecting tubing material suitable to the liquid being handled, a wide variety of corrosive, sterile, and abrasive liquids or gases can be pumped without contamination or injury to the pump.

The Randolph Pump's versatility has resulted in its immediate acceptance by many diverse industries utilizing processes where corrosion, contamination or abrasion were once a problem. Among these industries are firms engaged in the production of beverages, biochemicals, electro-plating, foods, frosted glass, paper pulp, pharmaceuticals, photo-engravings, plastic resins, synthetic fibers, textiles, and TV picture tubes.

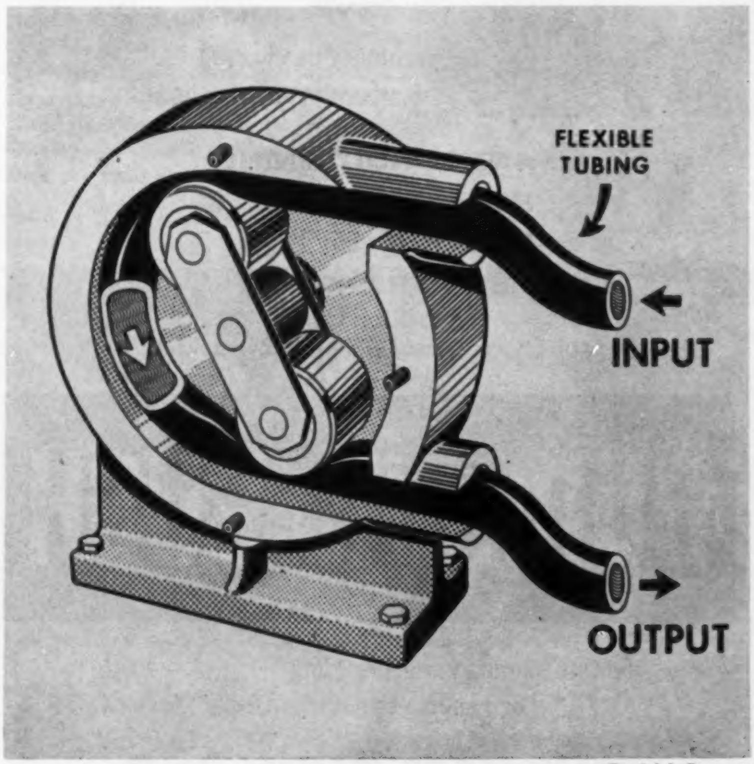
MAKING PETROLEUM NATURE'S WAY

Men of science have long wondered whether the natural formation of petroleum is continuous, or just a product of a certain geological period. After ten years of research, according to *Petroleum Week*, Texas A & M scientists have found an answer.

The scientists report that "organic action" may be producing petroleum today. They believe that certain clays, settling to form ocean beds, absorb animal matter, and undergo chemical changes of a type which could produce petroleum.

DETROIT VIEWS NEW STAINLESS ENGINE

Since the recent advent of aluminum engines, auto builders have been introduced to a new-type engine which may offer even greater advantages. The Tyce Engineering Corporation of California makes a stainless steel engine, called the Tyce/Taylor engine after its de-



Randolph Company

New Randolph pump makes use of flexible tubing for inlet and outlet to replace all contact of moving pump parts with fluid.

signer, Lloyd Taylor. It was exhibited at the Fifteenth Annual, American Society of Body Engineers, Technical Convention.

The four cylinder engine delivers a remarkable one horsepower per pound. It weighs 175 pounds, the block being made of brazed stainless steel sheet stamped to the thickness of a penny in some places. Special design features of the engine include: elimination of the head gasket, steel liners in the cylinders, and easily interchangeable crankshafts which convert the engine to four displacements – 91, 105, 120, and 135 cubic inches.

Although the engine has several innovations, and can give a tremendous 14 to 1 compression ration, it makes use of standard American auto parts. These include Chevrolet Six valve guides, Ford Six connecting rods, Thunderbird intake and Pontiac exhaust valves, and a choice between several transmissions such as the Corvette or Falcon units.

Tests have been made, and the powerplant will be used in sports car and auto races soon. The high performance and practicality of the engine indicate that it will be favorably accepted. Besides the automobile industry, there are good prospects for its use by the military.

BUILDING WITH "WOOD BRICKS"

One of the latest innovations in construction makes use of the oldest building material – wood. Southern Pine is actually made into "bricks" by the Southwestern Settlement and Development Company of Jasper, Texas, a division of the East Texas Pulp & Paper Company.

Building with the bricks is easy enough for persons with "average mechanical ability." Ordinary hand tools will do the job, which is simplified by the tongue and groove design of the bricks.

Using wood bricks eliminates constructing the several separate parts of a conventional wall – studs, sheathing, interior finishing, and exterior covering. The four inch thick bricks not only do this triple duty, replacing structure, interior, and exterior finishing; they give the same insulation as twenty-four inches of masonry.

FIFTY YEARS AGO IN THE ENGINEER

Edited by Robert Solomon, EE '64

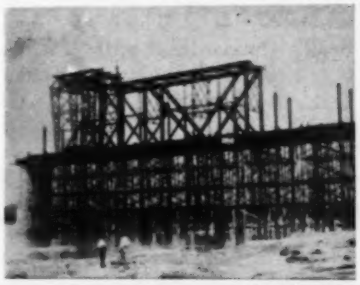
The Ann Arbor Railroad Co., a short line road operating almost exclusively in Michigan, has closed a contract for five self-propelled gasoline railroad cars of steel, which will take the place of some of the accomodation passenger cars on the road. These new cars will commence running first between Toledo, Ohio, and Ann Arbor, Mich., and it is the plan of the company to have the entire line equipped with them later. It is reported that the cars will be capable of high speed and will be operated by means of electric generators run by gasoline engines, and consequently no wires or poles will be necessary. —*The Sibley Journal*, April 1911.

Although the entire history of steel bridges and their immediate predecessors, wrought iron bridges, covers less than 50 years, their design, fabrication, and erection has reached a remarkable perfection of development in the United States, which easily leads all countries in this branch of Civil Engineering construction.

The enormous mileage of our railroads and the rapid growth of large cities has demanded a vast number of bridges and a length and height of spans never before proposed or possible.

The erection of bridges has been as highly specialized as their design and fabrication; it requires very superior quality and amount of ability and experience besides great courage, ingenuity and resourcefulness and has solved the most difficult and dangerous problems set by the designers.

With plenty of time and money and occasional disaster, almost everything not intrinsically impossible may be accomplished by any engineer, but the bridge builder has no such easy conditions. He



The Civil Eng.

Erecting Side Span of Thebes Bridge, on Falsework.

The Civil Eng.

Erecting floor system. Manhattan Suspension Bridge.

must and does accomplish the most difficult and unprecedented tasks with the minimum cost and maximum speed, with accuracy and safety, and must always do it in keen competition.

The one great feature of bridge erection is the rapid and accurate assembling permanently together of large and heavy steel units at great heights and under difficult conditions. It has infinite variety; no two problems are ever quite alike, but although there are many special and unique erections, most of them may be classified under one or another of several general types which, combined and modified, really cover nearly all the field. The plant required varies only with the magnitude of the span, the principal essentials being steam, electric and pneumatic power, hydraulic pressure, powerful tackles, hoisting and riveting machines, derricks, travelers and falsework, all of which are practically standardized. All but the last item are usually permanent plants maintained by the contractor and moved from bridge to bridge.—*The Civil Engineer*, April 1911.

Exceptionally active work is being done on the new Cleveland Electric Illuminating plant, which is in the course of construction. On account of the very severe winter and spring, the work was considerably delayed. A rough triangle was laid out, most of which was in the lake, and this area was cofferdammed. Wooden piles ranging from 30 to 60 feet were driven and heavy steel sheeting placed inside of this. So successful was the cofferdam, that very little seepage-water has entered. This has greatly facilitated the driving of the concrete piles which are to be the foundation for the plant. Since there is a bluff all along the lake front at this point, cars are run near the edge and a locomotive crane and bucket handle the raw materials to bins. Shutes connect the upper bins with the lower bins. A cableway between the bottom and top of the bluff has also done good work carrying wood, stone, brush, etc. A small gauge track conducts the concrete cars to the proper location and since a good many sidings are used, quick results are being obtained.—*The Sibley Journal*, April 1911.

The Loetschberg Tunnel through the Alps was holed through in March. The tunnel as originally planned, was a tangent 8⅝ miles in length, but on the choking up of over a mile near the northern end of the tunnel with sand, gravel and water, a change in alignment was made to avoid the material encountered in the first location. In this accident twenty-five workmen were killed and all the drills and equipment lost beyond all hope of recovery. This detour increased the length of the tunnel to 9.04 miles. It is to be double-tracked throughout, making it the second longest double-track in Europe, the St. Gothard being the longest.—*The Sibley Journal*, April 1911.

STRESS *and* STRAIN...

Edited by Mary Ellen Bertoni, Arts '61

On each desk in the Pentagon space agency, they now have one box for "out" and one for "outer."

• • •

Art Linkletter: "What is the lesson you have gained from the story of the Garden of Eden?"

Five-year-old boy: When a naughty little girl asks a little boy to do something naughty, they should do it when God isn't looking."

• • •

The trouble with trying to get get away from it all, these days, is that most of it is portable.

• • •

When a man checked into a New York hotel, he asked the desk clerk if his room had a television. "No, sir, we do not supply television sets in our rooms," the clerk replied. "This is a thinking man's hotel."

• • •

One typewriter manufacturer offers a "blur-rite" key to be added to the regular keyboard. When you're not sure of the next letter in a word you push the special one and it types a neat blur. Result: no more misspelled words.

• • •

A woman whose husband is a chemical engineer for an oil company moved from Abilene to Wichita Falls soon after she became pregnant. In a few months they were transferred back to Abilene, at which time she went to her former doctor for a checkup. The receptionist asked if the doctor had ever delivered a baby for her. Imagine the reaction of the entire waiting room when the woman innocently replied, "No, but he started this one."

• • •

Overheard in the lobby of the Tishman Building, one beautiful young creature to another: "The only way you can attract attention to yourself in *that* office is to bend your I.B.M. card."

A drunk boarded a bus and sat down next to an elderly, gray-haired lady.

"You may not know it," said the old lady, "but you're going straight to Hell, young man."

The drunk jumped to his feet and hollered to the driver, "My gawd, let me off; I'm on the wrong bus."

• • •

A small college opened up in the Midwest and when the first semester began, the college president discovered that there was not enough room in the dormitory for all the students. So the president decided to quarter the male students and the coeds in the gymnasium. Since there was not time to put up a partition, he painted a heavy white line down the center of the gym. Then he told the students: "If any of you crosses the white line into the side of the gym that belongs to the other sex, you will be fined $5 for the first offense, $10 for the second offense, $20 for the third offense, and so forth. Are there any questions?"

"Yes sir," one of the male students asked promptly. "What's the rate for a season ticket?"

• • •

Student looking through telescope: "God"

Another: "Aw, g'wan, it isn't that powerful."

• • •

"Your husband looks like a brilliant man. I suppose he knows everything."

"Don't be silly. He doesn't suspect a thing."

• • •

One reason for not picturing angels with beards it that most of them get to heaven by a close shave.

• • •

M.E.: "Alas, drink broke up my home."

E.E.: "What's the matter, couldn't you lay off the stuff?"

M.E.: "No, my still exploded."

A young engineer got a job in a remote mining camp. On his first day off, he approached the boss and asked: "Say, boss, what do you folks do around here for amusement?"

The boss replied, "Well, all of us usually watch Sam, the cook, drink a gallon of whiskey, gasoline, and red pepper juice. It's the funniest thing you ever saw. Why don't you come along?"

The young engineer was obviously shocked. "No thanks," he said, "I don't go in for that kind of amusement."

"Well," answered the boss, "I sure wish you'd come. We really need six men for this thing."

"Why is that?" asked the new man.

"Some of the boys have to hold Sam. He don't go for that kind of amusement either."

• • •

Once upon a time, as the story goes, the fence between Heaven and Hell broke down. Satan appeared at his side of the broken section and called out to St. Peter, "Hey St. Peter, since all the engineers are over on your side, how about sending a few to fix the fences?"

"Sorry," replied St. Peter, "my men are too busy to fix fences."

"Well then," said Satan, "I'll have to sue you if you don't."

St. Peter: "Guess you win; you've all the lawyers on your side."

• • •

Man: "I want to buy a pillow-case."

Salesgirl. "What size?"

Man: "I don't know, but I wear a size seven hat."

• • •

Fellow to blind date: "I never really believed in reincarnation—but what were you before you died?"

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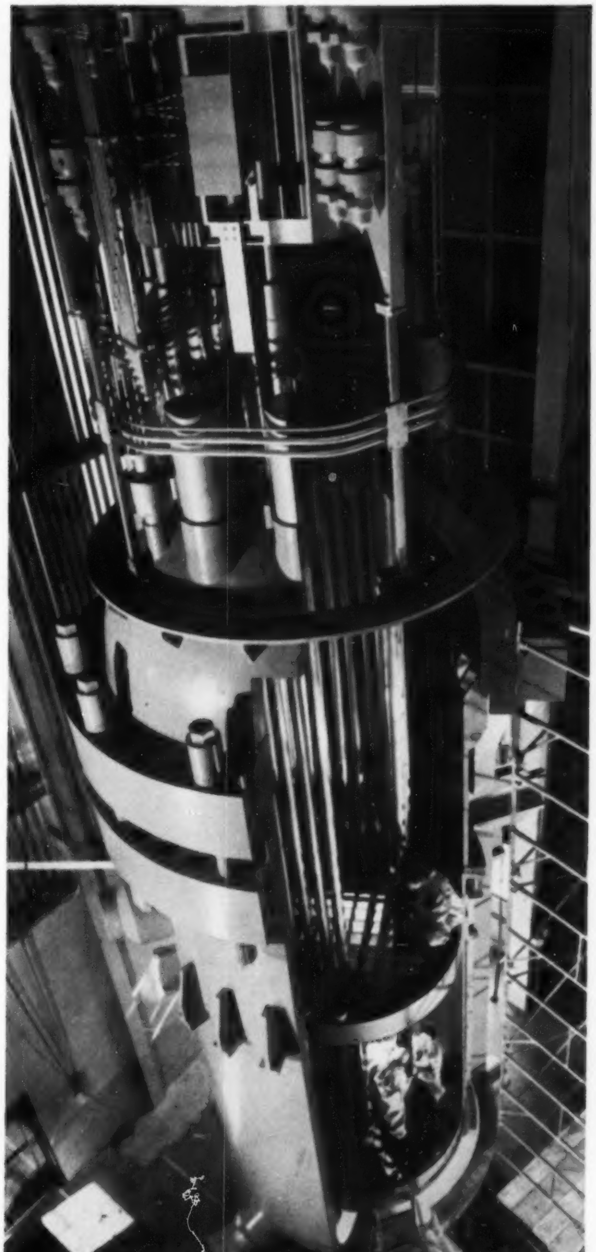

Mock-up of the Shippingport (Pa.) Atomic Power Station reactor which was designed and developed by the Westinghouse Electric Corporation under the direction of and in technical cooperation with the Naval Reactors Branch, U.S. Atomic Energy Commission.

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TRADE MARK

One of a series*

Interview with General Electric's
Charles F. Savage
Consultant—Engineering Professional Relations

How Professional Societies Help Develop Young Engineers

Q. Mr. Savage, should young engineers join professional engineering societies?

A. By all means. Once engineers have graduated from college they are immediately "on the outside looking in," so to speak, of a new social circle to which they must earn their right to belong. Joining a professional or technical society represents a good entree.

Q. How do these societies help young engineers?

A. The members of these societies—mature, knowledgeable men—have an obligation to instruct those who follow after them. Engineers and scientists—as professional people—are custodians of a specialized body or fund of knowledge to which they have three definite responsibilities. The first is to *generate* new knowledge and add to this total fund. The second is to *utilize* this fund of knowledge in service to society. The third is to *teach* this knowledge to others, including young engineers.

Q. Specifically, what benefits accrue from belonging to these groups?

A. There are many. For the young engineer, affiliation serves the practical purpose of exposing his work to appraisal by other scientists and engineers. Most important, however, technical societies enable young engineers to learn of work crucial to their own. These organizations are a prime source of ideas — meeting colleagues and talking with them, reading reports, attending meetings and lectures. And, for the young engineer, recognition of his accomplishments by associates and organizations generally heads the list of his aspirations. He derives satisfaction from knowing that he has been identified in his field.

Q. What contribution is the young engineer expected to make as an active member of technical and professional societies?

A. First of all, he should become active in helping promote the objectives of a society by preparing and presenting timely, well-conceived technical papers. He should also become active in organizational administration.
This is self-development at work, for such efforts can enhance the personal stature and reputation of the individual. And, I might add that professional development is a continuous process, starting prior to entering college and progressing beyond retirement. Professional aspirations may change but learning covers a person's entire life span. And, of course, there are dues to be paid. The amount is graduated in terms of professional stature gained and should always be considered as a personal investment in his future.

Q. How do you go about joining professional groups?

A. While still in school, join student chapters of societies right on campus. Once an engineer is out working in industry, he should contact local chapters of technical and professional societies, or find out about them from fellow engineers.

Q. Does General Electric encourage participation in technical and professional societies?

A. It certainly does. General Electric progress is built upon creative ideas and innovations. The Company goes to great lengths to establish a climate and incentive to yield these results. One way to get ideas is to encourage employees to join professional societies. Why? Because General Electric shares in recognition accorded any of its individual employees, as well as the common pool of knowledge that these engineers build up. It can't help but profit by encouraging such association, which sparks and stimulates contributions.

Right now, sizeable numbers of General Electric employees, at all levels in the Company, belong to engineering societies, hold responsible offices, serve on working committees and handle important assignments. Many are recognized for their outstanding contributions by honor and medal awards.

These general observations emphasize that General Electric does encourage participation. In indication of the importance of this view, the Company usually defrays a portion of the expense accrued by the men involved in supporting the activities of these various organizations. Remember, our goal is to see every man advance to the full limit of his capabilities. Encouraging him to join Professional Societies is one way to help him do so.

Mr. Savage has copies of the booklet "Your First 5 Years" published by the Engineers' Council for Professional Development which you may have for the asking. Simply write to Mr. C. F. Savage, Section 959-12, General Electric Co., Schenectady 5, N. Y.

***LOOK FOR** other interviews discussing: Salary • Why Companies have Training Programs • How to Get the Job You Want.*

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